Report No. FAA RD 72-58,I

LATERAL SEPARATION

VOLUME I

STUDY RESULTS

Advanced Systems Department
Resalab Incorporated
Dallas, Texas 75217

JULY 1972

FINAL REPORT

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Prepared for

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

Systems Research & Development Service

Washington D. C., 20591

Code A,
Per, Margaret Hall, thru Mr. John Meyer
18 Oct 72

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-72-58,I		

4. Title and Subtitle	5. Report Date / 6. Performing Organization Code
LATERAL SEPARATION VOLUME I STUDY RESULTS	5. Report Date: July 1972 6. Performing Organization Code:
7. Author(s) Advanced Systems Department	8. Performing Organization Report No.
9. Performing Organization Name and Address Resalab, Incorporated Dallas, Texas 75217	10. Work Unit No. Project 142-177-031 11. Contract or Grant No. DOT-FA71WA-2609
12. Sponsoring Agency Name and Address FEDERAL AVIATION ADMINISTRATION Systems Research and Development Service Washington, D. C. 20591	13. Type of Report and Period Covered Final Report June 1971 to July 1972 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The Lateral Separation Study provides a means of establishing the feasibility of minimizing runway spacings for the purpose of increasing terminal IFR operational capacity. In this report, normal operating zone data, probability of collision data, and the blunder recovery airspace requirements are presented. The methods of combining this data to determine the minimum spacing for various types of approaches and operations are discussed. The techniques used to generate the data referenced above are summarized in this volume and presented in detail in Volume II.

17. Key Words	18. Distribution Statement
Minimum Runway Lateral Separation Probability of Collision, Fokker-Planck, Blunder Recovery Area, Normal Operating Zone	Availability is unlimited. Document may be released to the National Technical Information Service, Springfield, Virginia 22151, for sale to the public.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	~~260~~ 349	$3.00 PC .95 MF

Form DOT F 1700.7 (8-69)

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SECTION 1

INTRODUCTION

Terminal operational capacity could be increased by reducing the present lateral separation criteria between independent Instrument Flight Rules (IFR) operations on parallel runways and by establishing a basis for separation criteria for Conventional Take-Off and Landing/Short Take-Off and Landing (CTOL/STOL) operations for parallel or skewed runways. The objective of the Lateral Separation Study is to provide a means for establishing the feasibility of minimizing runway spacings for the purpose of increasing the terminal operational capacity.

The Lateral Separation Study provides a method for determining the minimum lateral spacing between runways and measuring the relative safety for a given runway spacing. Volume I of this report summarizes the procedures used to obtain the required data and discusses the application and use of this data. The basic objectives of Volume II are to discuss in detail, the development of the techniques used to generate the data and to present the data used in the determination of minimum runway spacings.

A presentation of the list of data essential to the determination of minimum runway spacings and a brief description of the problems associated with the generation of this data are contained in Section 1.1. Briefly, this data includes normal operating zone data, probability of collision data, and blunder recovery data.

Section 2 provides a summary of the methods used to determine the NOZ, probability of collision, and blunder recovery airspace data. The basic approach used in generating this data was to obtain statistical descriptions of the location errors (probability density functions) of aircraft operating under IFR conditions. The probability density functions in turn were used directly to compute the probability of collision data and normal operating zones. The lateral error probability density functions were obtained from the Fokker-Planck equation. The Fokker-Planck equation uses the system dynamics, provided by approach system models, and an initial lateral distribution, provided by measured distribution data, to propagate the probability density function in time. A deterministic analysis which included a parametric variation of the pertinent system parameters was used to generate the blunder recovery airspace requirements.

The results required to determine the minimum runway spacings are discussed in Section 3 and presented in the appendices.

The methods for determining minimum runway spacing requirements and for measuring the relative safety for a given spacing for parallel or skewed runways are presented in Section 4. In addition to minimum runway spacing considerations, the situation where runway spacings are fixed is also considered. In this case, methods are provided for identifying acceptable operations and for determining relative safety. The aircraft and runway configurations considered include CTOL/CTOL, CTOL/STOL, and STOL/STOL. The methods are based upon probability of collision data, NOZ data, and blunder recovery airspace data.

SECTION 1.1

PROBLEM DEFINITION

As stated previously, the objective of this study is to provide a means to establish the feasibility of minimizing runway spacings for the purpose of increasing the terminal IFR operational capacity. This objective is accomplished by providing a method for determining the minimum lateral spacing between runways and for measuring the relative safety for a given runway spacing.

It is necessary to provide a method for determining minimum runway spacings for the following aircraft and runway configurations:

(1) CTOL/CTOL - parallel,
(2) CTOL/STOL - parallel at different threshold locations,
(3) CTOL/STOL - skewed, and
(4) STOL/STOL - parallel.

The method should be capable of handling the following approach systems:

(1) front course Instrument Landing System (FC-ILS),
(2) back course Instrument Landing System (BC-ILS), and
(3) VHF omni-directional range/distance measuring equipment (VOR/DME).

Both independent and dependent operations should be considered, as well as arrivals, departures, missed approaches, and blunders.

The problems specific to Volume I of this report are the determination of a procedure for obtaining the minimum runway spacings and relative safety considerations, which are based upon the following:

(1) no transgression zones,
(2) normal operating zones,
(3) blunder recovery airspace, and
(4) probability of collision.

The normal operating zones should be determined for FC-ILS, Category I, CTOL approaches; FC-ILS, Category II, CTOL approaches; BC-ILS, Category I, CTOL approaches; FC-ILS, Category I, STOL approaches; and VOR/DME, CTOL approaches. These normal operating zones should be such that either 68% or 95% of the operations are contained in the zone.

The blunder recovery area should be determined for

combinations of parameters which include a set of extreme deviation situations, a set of data acquisition systems having various accuracies and update rates, a set of rules and procedures, a set of aircraft/pilot performance characteristics, a set of communication times, and a set of measurement techniques.

The runway separation evaluation data should be determined for independent parallel CTOL operations for front course ILS/front course ILS, front course ILS/back course ILS, and front course ILS/(VOR/DME) approaches. This data should also be determined for dependent parallel CTOL front course ILS approaches with various longitudinal separations and for independent parallel CTOL/STOL and STOL/STOL front course ILS approaches for specific STOL runway threshold locations.

A procedure for determining minimum runway spacings should be determined for:

1) Parallel runways and independent operations for:
   - FC-ILS-CTOL/FC-ILS-CTOL
   - FC-ILS-CTOL/BC-ILS-CTOL
   - FC-ILS-CTOL/(VOR/DME)-CTOL
   - FC-ILS-CTOL/FC-ILS-STOL (different runway threshold locations)
2) Parallel runways and dependent operations for:
   - FC-ILS-CTOL/FC-ILS-CTOL
3) Skewed runways and independent operations for:
   - FC-ILS-CTOL/FC-ILS-STOL with due consideration for approaches, departures, and missed approaches.

Once the minimum spacing problem is solved for CTOL/CTOL, CTOL/STOL, and STOL/STOL, the effect on the terminal operational capacity could be determined.

SECTION 2

SUMMARY OF METHOD OF SOLUTION

The problem addressed in Section 1 is that of increasing the terminal operational capacity. A method of solving this problem is by reducing the lateral separation criteria between parallel runways for independent IFR operations and by establishing a basis for separation criteria for CTOL/STOL operations for runways oriented either parallel or skewed. This new separation criteria should be developed such that minimum runway spacings are obtained for specified safety requirements and approach system configurations.

The objective of the methodology summarized in the following sections and discussed in detail in Volume II is the determination of the data required to obtain values for the minimum spacing between CTOL/CTOL, CTOL/STOL, and STOL/STOL runways under various operational procedures. This methodology is illustrated in block diagram form in Figure 2-1.

Basically, this methodology involves the derivation of system models that include approach system characteristics such as pilot performance, aircraft performance, instrument approach system response and errors, controller interaction, etc. These models are discussed in further detail in Section 2.1.

Using these models, a set of state equations were derived, and the corresponding Fokker-Planck partial differential equation was then discussed. The development of the Fokker-Planck equation is described in Section 2.2.

The location error data collected at Chicago, Portland, Atlanta, NAFEC, and Charleston was then processed to yield the measured aircraft error distributions. The lateral distributions were used to initialize the Fokker-Planck equation, to aid in verification of the system models, and used in the probability of collision determination. A description of this effort is included in Section 2.3.

Verification of the system models was accomplished by comparing observed quantities from the physical system to those quantities predicted by the models as discussed in Section 2.4. In an effort to determine the dominant system parameters, a sensitivity analysis was completed using both a deterministic and a statistical model. The approach used in this investigation is also included in Section 2.4.

Using the initial lateral measured error distributions and the verified Fokker-Planck equation, the aircraft

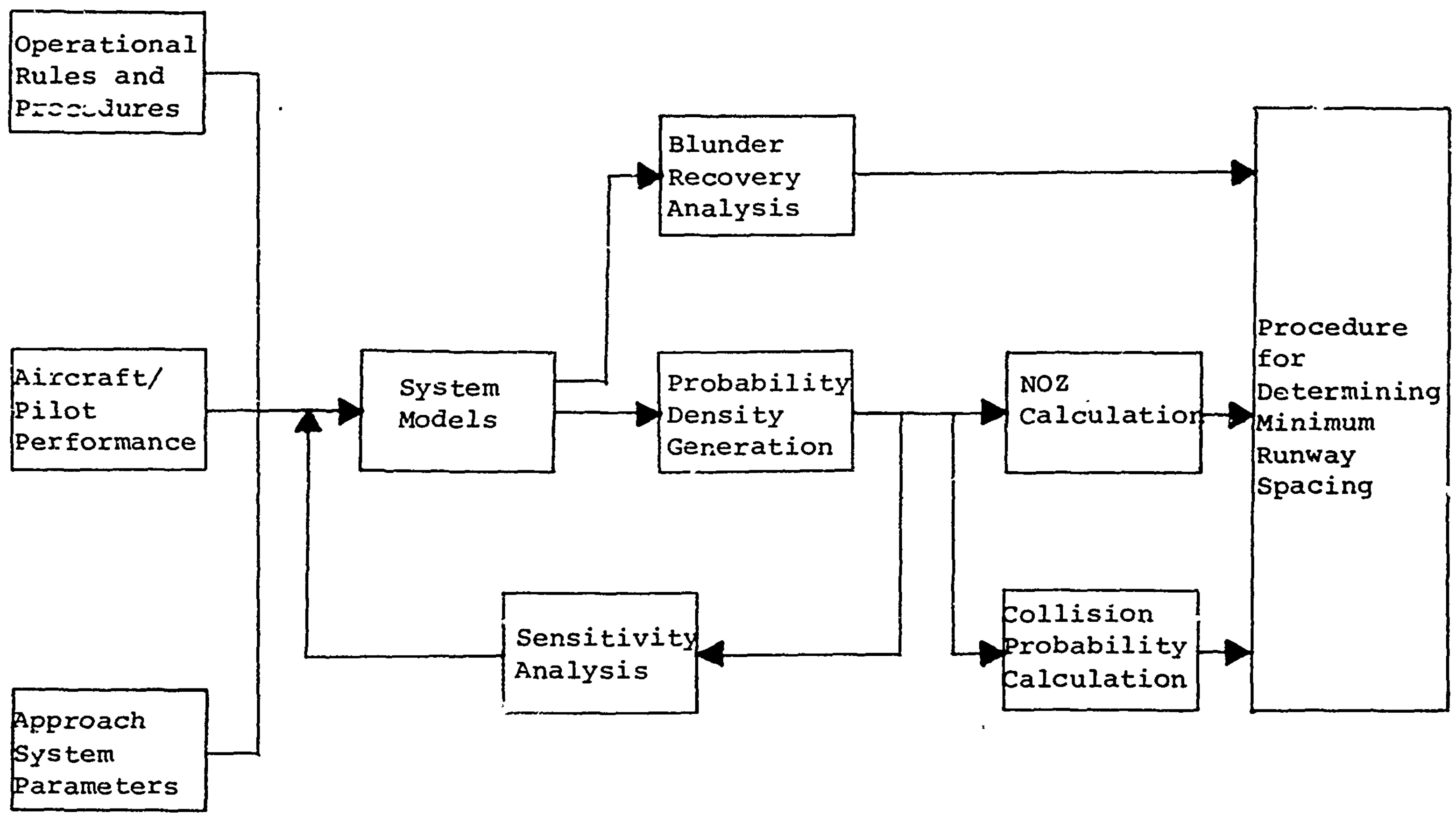

Figure 2-1 Method of Solution

positional error distributions, or probability density functions, from the initial range to the decision height were computed as described in Section 2.5. These density surfaces are the statistical description of the positional errors of the aircraft at time or range intervals along the approach. The models and the corresponding Fokker-Planck equation were developed such that it was possible to vary the parameters of the models (equations) to determine the lateral error distributions for each of the required operational procedures. The normal operating zones (the area containing 68% or 95% of the aircraft operations) were then computed directly from the lateral error distributions. Vertical and longitudinal probability density functions were also obtained as discussed in Section 2.5.

Then the probability of collision for the various operational procedures and runway configurations were determined. The definition of these collision probabilities and the methods of obtaining them are described in Section 2.6.

The effect of those aircraft that deviate beyond the NOZ due to blunder conditions were investigated. The determination of the recovery airspace required for various blunder situations was accomplished using a deterministic approach. The determination of the recovery airspace is described in Section 2.7.

As indicated in Figure 2-1, the primary results of the methodology described in Sections 2.1 through 2.7 are the NOZ, blunder recovery area, and collision probabilities for the various operational procedures, aircraft/pilot performance, and approach system parameters. A systematic combination of this data using specified safety requirements and approach system parameters results in a minimum runway spacing. The procedures for determining the minimum runway spacing are discussed in Section 4.

The following sections synopsize the methodology used to determine the data required for the determination of the minimum runway spacing. A detailed technical description of the methodology in these sections is included in the companion report, Volume II.

SECTION 2.1

SYSTEM MODEL DEVELOPMENT

After a thorough examination of the problem definition, discussed in Section 1.1, the method of solution, discussed in Section 2, was formulated. The first major effort involved in accomplishing the method of solution is the development of mathematical models which describe the required approach systems. To aid in model development and verification tasks, a comprehensive literature survey was conducted, resulting in the models described in this section. The approach systems investigated and modeled in this study are described in Table 2.1-1. The development of mathematical models which describe these approach systems is discussed in the sections which follow.

Due to similarities in these approach systems, a nominal system model is developed which represents all of the above approach systems. The nominal model equations and certain model parameter values are representative of all of the above approach systems; however, some model parameters are specific

Table 2.1-1 Approach Systems

Designation	Primary User Class	Runway Type	Approach Guidance System
FC-ILS-I-CTOL	CTOL Category I	CTOL	Front Course, ILS, Category I
FC-ILS-II-CTOL	CTOL Category II	CTOL	Front Course, ILS, Category II
BC-ILS-I-CTOL	CTOL Category I	CTOL	Back Course, ILS, Category I
VOR-CTOL	CTOL Category I	CTOL	VOR (tracking inbound to a station within the airport boundary)
FC-ILS-I-STOL	STOL Category I	STOL	Front Course, ILS, Category I

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to each approach system. The nominal model is defined as a front course, instrument landing system, Category I and Category II combination, conventional take off and landing aircraft and runway (FC-ILS-INOM-CTOL).

Section 2.1.1 establishes the operational concepts for the system models. A discussion of the nominal model development is contained in Section 2.1.2. Various required expansions of the nominal model to encompass the operational concepts are discussed in Section 2.1.3. Section 2.1.4 contains an error definition discussion for the various approach systems. Section 2.1.5 discusses the model state equation derivation for use in the Fokker-Planck analysis. Verification of the nominal system model is discussed in Section 2.4. A detailed technical development of the system model is contained in Volume II of this report.

2.1.1 MODEL CONCEPT DEFINITION

Before a reasonable system model can be developed, it is necessary to plan all required phases of the analysis and relate the model to each phase by predetermining how the model will be utilized. It is also necessary to establish a set of ground rules and assumptions to serve as a guideline throughout model development and subsequent model usage. Additionally, it is necessary to define the general model structure by identifying the major components and their corresponding interconnections. The purpose of this section is to accomplish these objectives.

The basic model concepts are derived by considering all factors which affect an aircraft's lateral deviation from a runway localizer beam. Consideration of these factors results in the model structure shown in Figure 2.1.1-1. The major components contained in the model structure are the aircraft, pilot, course deviation indicator and ground controller. The component interconnections are also shown in Figure 2.1.1-1.

Runway lateral separation requirements, as defined in this study, are based upon the assumptions that (1) the approach system's lateral and vertical tracking dynamics are independent and (2) the aircraft is to remain in the glideslope plane except when executing a missed approach. These assumptions allow the results obtained from this study to reflect the "worst case" possibility. Based upon these assumptions, the system model simulates lateral control only.

After a thorough investigation of the objectives of this study, the model's operational concepts were established. The expanded system models (Section 2.1.3) are capable of IFR operations for CTOL or STOL aircraft operating on CTOL or STOL

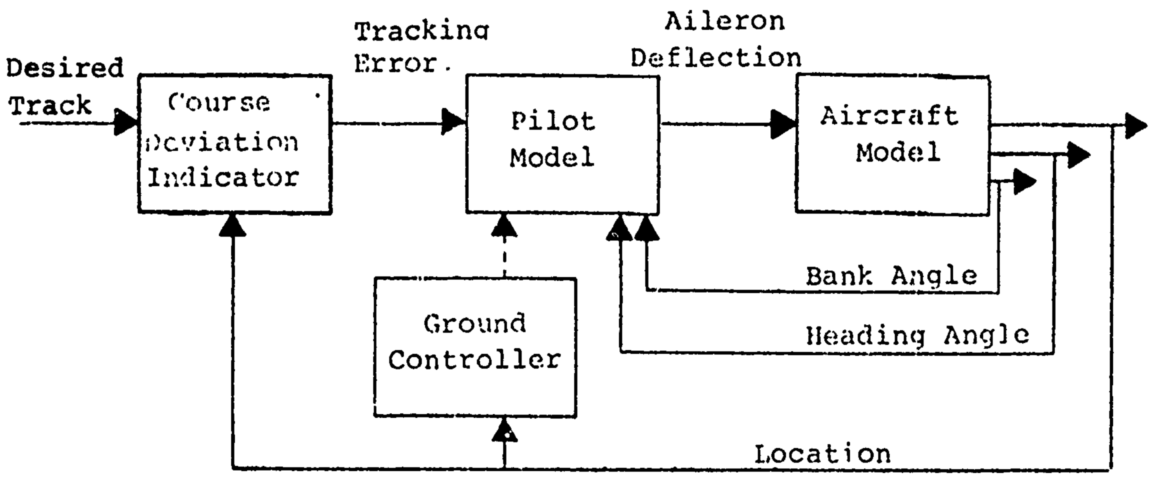


Figure 2.1.1-1 General System Model

runways with either an ILS (Category I or Category II) or VOR approach guidance system. The expanded models can simulate arrivals or departures and independent or dependent operations on single or multiple (parallel or skewed) runway configurations. They can simulate both straight-in approach paths and general curved three-dimensional approach paths, and have the capability of simulating missed approaches.

The approach system models are used in the generation of supporting data which will be used in the determination of the minimum lateral runway separation criteria. The state equations derived from the model are utilized in the Fokker-Planck analysis which generates probability density functions which in turn are used in the probability of collision analysis. The system model is also utilized in the blunder analysis, which defines lateral recovery airspace requirements for various blunder conditions.

The expanded models may be used as analysis tools to study approach systems. Certain terminal system parameters and/or system errors may be varied and the effects on the total system response observed. The models may be used in the prediction of distribution data for systems in which no measured field data exists. Certain system characteristics which are difficult to observe in the actual approach system (such as multiple aircraft relative velocities and locations, aircraft bank angle and heading angle, curved path characteristics, etc.) may be obtained easily from these expanded system models.

2.1.2 NOMINAL MODEL

2.1.2.1 Introduction

The purpose of the nominal model is to simulate a composite set of CTOL aircraft flying the final leg of a front course ILS approach under IFR conditions. The model is also used to develop and check the state equations used in the Fokker-Planck analysis and to establish a data base to which more complex models may be compared.

To determine the requirements of the nominal model, an analysis of the various components included in an ILS approach was undertaken. The various subsystems identified were then studied to allow development of simple yet accurate mathematical models of the subsystem response. For each subsystem various basic assumptions were used to determine the modeling requirements.

A linear version of the nominal model was developed for use in the Fokker-Planck analysis.

2.1.2.2 Approach

The development of the nominal model was based on the general block diagram of the system presented in Section 2.1.1 (Figure 2.1.1-1).

Assumptions

Assumptions used in the development of the nominal model include

1) the system's lateral and vertical tracking dynamics are independent, and
2) the aircraft remains in the glideslope plane except when executing a missed approach.

These assumptions result in a study reflecting the "worst case" possibility. Thus, the system model simulates lateral control only.

The aircraft will be assumed to perform coordinated turns in the glideslope plane in order to nullify any lateral displacement error. This assumption simplifies the aircraft dynamics equations.

Course Deviation Indicator (CDI) Model

The CDI model computes the angular error of the aircraft measured from the localizer beam in the glideslope plane.

The CDI simulator relates the lateral displacement error magnitude to the displayed angular error as a function of range from the lateral guidance transmitting antenna as shown in Figure 2.1.2-1. Thus, a 500 foot error at ten miles from the antenna displays less needle deflection than the same 500 foot error would command at two miles from the antenna. This is representative of the variable sensitivity found in actual CDI operation.

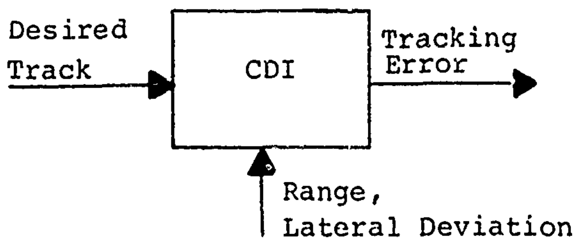


Figure 2.1.2-1 Course Deviation Indicator Model

Pilot Model

Selected feedback loops closed by the pilot for the localizer displacement control task are presented in Figure 2.1.2-2. The pilot commands a bank angle to the aileron control loop based on his perception of heading error in a secondary loop. The heading error is based on a heading reference established by his perception of localizer deviation. The bank angle is the pilot's primary controlling parameter.

The pilot model approximates the pilot response by a pure time delay and a lead. The time delay represents the pilot/control delay, characteristic of human delays and aircraft control system delays, and the lead simulates the pilot's anticipatory ability. However, in order to develop a pilot model in a form suitable for use in the Fokker-Planck analysis, the pilot/control time delay was replaced by a simulated time delay.

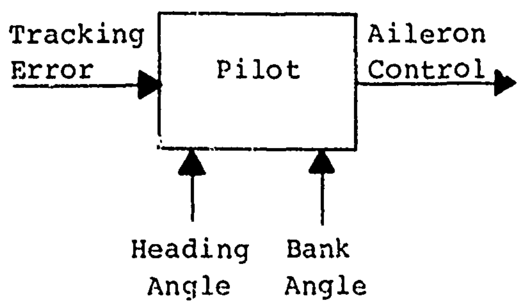


Figure 2.1.2-2 Pilot Model

Aircraft Model

In the determination of approach system lateral distribution data, it is necessary to consider the aircraft's dominant lateral dynamics only. Due to the dominant long term nature of the approach system dynamics, the aircraft's short term transient motion becomes negligible; therefore, it is assumed that the aircraft's lateral dynamics can be simulated by representing the aircraft bank rate response to aileron input by a time lag with a limited bank rate and turn rate. These limits are imposed by pilot acceptability and passenger comfort considerations.

The pilot is assumed to cause the aircraft to perform coordinated turns in the glideslope plane to nullify lateral deviation errors. This assumption is utilized in the derivation of the aircraft equations of motion which describe the heading and location of the aircraft as a function of bank angle and time. The aircraft model is shown in Figure 2.1.2-3.

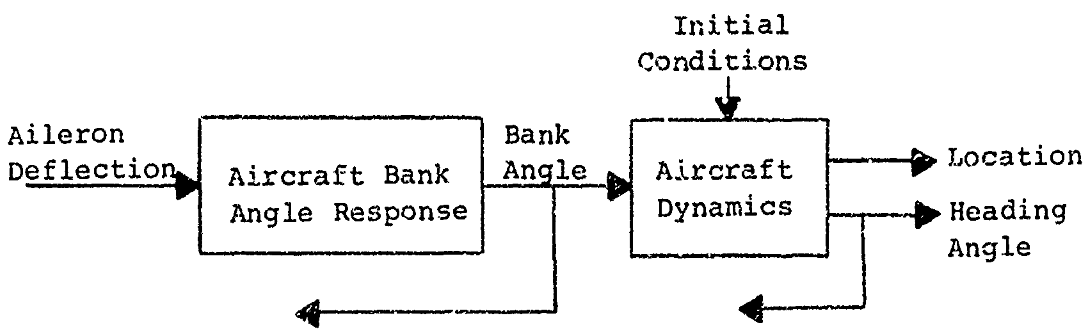


Figure 2.1.2-3 Aircraft Model

Total System

While flying an ILS approach, the pilot sees an error displayed on the CDI. After some nominal physiological delay he uses the magnitude and direction of the error to command an aileron deflection which causes the aircraft to bank, resulting in a heading change. The new heading tends to reduce the error and the CDI indicates a smaller error.

The CDI, pilot, and aircraft models are connected and related in a manner which accurately simulates the actual system. The CDI model computes the error from the ILS centerline which is input to the pilot model. Also input into the pilot model are the heading and the bank angle of the aircraft. The pilot model simulates the pilot's anticipation of the aircraft heading and bank angle change and then commands some

aileron deflection. The aileron deflection is used to determine the aircraft bank rate and heading change. The aircraft attitude and direction are used to compute the updated position and the CDI takes the information and generates a new error for the pilot model.

Inherent in every physical system are several error sources (or noise sources). The types of errors which primarily affect the lateral approach system dynamics are lateral guidance equipment transmitting and receiving errors and pilot errors. Pilot error sources are assumed to occur at each input to the pilot - bank angle, heading angle, and localizer tracking error. Included in these pilot error terms are such things as pilot attitude, indicator equipment accuracy and any other contributors which affect the pilot's ability or desire to react to actual conditions. Since the bank angle is the pilot's primary controlling parameter, pilot attitude errors are primarily included in the bank angle error.

The implementation of the total system is illustrated in the block diagram of Figure 2.1.2-4.

For use in the Fokker-Planck analysis, it was necessary to develop a linear version of the nominal model. The development of the linearized model was accomplished by replacing the nonlinear portions of the nominal model with accurate linear approximations.

2.1.2.3 Nominal Model Results

The nominal model (Figure 2.1.2-4) has been programmed in a FORTRAN IV language computer routine for ease of use in the various analyses.

The nominal model parameter values were obtained from several sources including: a literature search, fitting measured distribution data, and, where necessary, assuming values.

Each feedback loop in the nominal model has been verified by comparison of the simulated response to the expected response. The linear model was verified by comparing its response to the response of the nonlinear nominal model.

A discussion of the verification of the nominal model is contained in Section 2.4.

2.1.3 EXPANDED MODELS

The nominal model described in Section 2.1.2 has been expanded to encompass the specific operational concepts defined in Section 2.1.1. The model expansion task may be broken into two parts:

1. Approach System Models (Section 2.1.3.1)

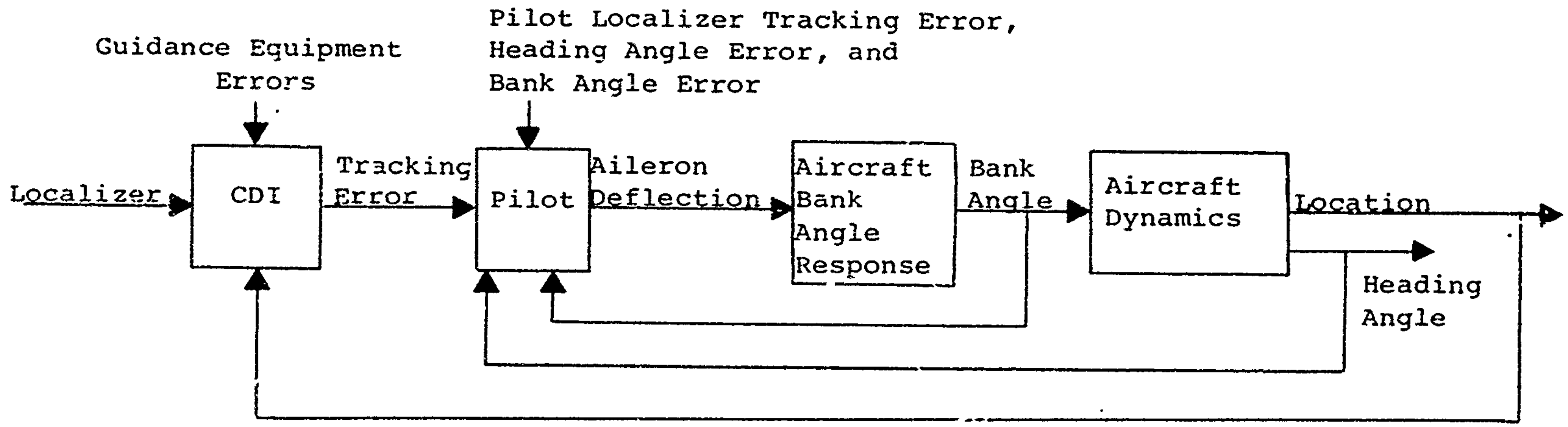


Fig re 2.1.2-4 Nominal System Model

2. Curved Path and Multiple Aircraft/Runway Models (Section 2.1.3.2)

The approach system models are based on the systems listed in Table 2.1-1 and are developed for use in the generation of the probability density functions which are used in the probability of collision analysis. The curved path model and multiple aircraft/runway model are developed for use as approach system analysis tools.

2.1.3.1 Approach System Models

The specific approach systems modeled in this study from Table 2.1-1 are:

1. FC-ILS-I-CTOL
2. FC-ILS-II-CTOL
3. BC-ILS-I-CTOL
4. VOR-CTOL
5. FC-ILS-I-STOL

Due to similarities in the above approach systems, the nominal model block diagram developed in Section 2.1.2 (Figure 2.1.2-4) is valid for all of these systems. The nominal model equations and certain model parameter values are representative of all of the above approach systems; however, some model parameter values are specific to each approach system and thus distinguish the different approach system models from one another.

An analysis of each particular item necessary to model the specified approach systems was performed. The model parameter values for each specific approach system are determined from the above analysis and by fitting models to measured distribution data (from Section 2.3) for each approach system, as discussed in Section 2.5.

A brief description of each of the approach systems is contained below.

FC-ILS-I-CTOL (Front Course - Instrument Landing System - Category I - Conventional Take Off and Landing)

In this system a ground-based transmitter generates a set of beams in such a manner that the airborne receiver can determine, and indicate to the pilot, the position of the aircraft with respect to the extended runway centerline and an optimum glideslope. Under the stated assumptions it is not necessary to consider the glideslope guidance; therefore, the remaining discussion will be limited to the localizer. The optimum track of the aircraft is precisely along the extended runway centerline (localizer). However, due to various

random error sources, this optimum track is seldom achieved. Changes in the position of the aircraft with respect to the localizer are presented to the pilot via the CDI or Flight Director (FD). The pilot, observing the CDI, commands an aileron deflection. The command causes the aircraft to move laterally in a coordinated turn. The basic system components (CDI, pilot, aircraft and monitoring controller) and their interconnections are illustrated in Figure 2.1.1-1.

FC-ILS-II-CTOL (Front Course - Instrument Landing System - Category II - Conventional Take Off and Landing)

This system is essentially the same as the Category I system previously described. However, in this system the calibration and degree of allowable drift of the localizer are held within tighter bounds as discussed in Section 2.1.4.

BC-ILS-I-CTOL (Back Course - Instrument Landing System - Category I - Conventional Take Off and Landing)

The back course ILS localizer beam is generated by the same ground equipment as the front course; therefore, this system is essentially the same as the systems discussed above. However, on a back course approach the aircraft, at a given range from touchdown, is closer to the localizer antenna. Thus, the system is more sensitive to guidance errors.

VOR - CTOL (VHF Omnidirectional Range - Conventional Take Off and Landing)

This system differs from the previously discussed ILS in that the ground station transmits information in such a manner that the receiving equipment in the aircraft can determine the magnetic bearing to (or from) the VOR station. Thus, if a VOR station is located at or near an airport, this station can be used with appropriate procedures to affect landing during IFR weather conditions. This requires that the aircraft fly to (or from) the VOR station on a specified radial which is input to the omnibearing selector (OBS). The deviations from the selected radial are presented to the pilot on the CDI. The remainder of the model is as discussed in the ILS above.

FC-ILS-I-STOL (Front Course - Instrument Landing System - Category I - Short Take Off and Landing)

This system is similar to the FC-ILS-I-CTOL except that the glideslope is normally elevated to about 7.5° versus 2.5° for CTOL and the primary user class is STOL aircraft.

Also the final approach length is much shorter (2-3 N. Mi.) than for CTOL (5 N. Mi. or greater).

2.1.3.2 Curved Path Model and Multiple Aircraft/Runway Model

The curved path and multiple aircraft/runway models are developed for use as analysis tools to study approach systems. Certain terminal system parameters and/or system errors may be varied and the effects on the total system response observed. The models may be used in the prediction of distribution data for systems in which no measured field data exists. Certain system characteristics which are difficult to observe in the actual approach system (such as multiple aircraft relative velocities and locations, aircraft bank angle and heading angle, curved path characteristics, etc.) may be obtained easily from these system models.

Curved Path Model

The nominal model of Section 2.1.2 has been extended to include a three-dimensional curved approach path. This model may be used to study the approach of aircraft along a curved path. The curved path uses two legs (a base and a final) and a commanded standard-rate turn from base leg to final leg to simulate a curved approach. This model can also simulate departures and missed approaches.

The curved path approach model was developed by adding a base leg and a commanded standard-rate turn to the nominal model. The single base leg was deemed sufficient to allow a complete study of various curved approaches. ILS control while the aircraft is on the base leg is not range dependent; that is, a displacement error rather than an angular error is used to command aircraft motion. The displacement error method is more representative of a controller observing a radar display and giving heading vectors and turn commands. The displacement error has a constant sensitivity for all ranges, whereas an ILS has a range dependent sensitivity. A standard-rate turn is normally used to maneuver the aircraft onto the final leg of the approach. Figure 2.1.3-1 illustrates the curved approach geometry and the different error logic used on each approach leg.

The desired turn rate is an input parameter to the standard-rate turn maneuver, and any reasonable rate may be chosen. The bank angle, which would give the desired turn rate, is computed based on the input turn rate plus some random turn rate error and the aircraft velocity. The range at which the turn is commenced is a function of aircraft velocity,

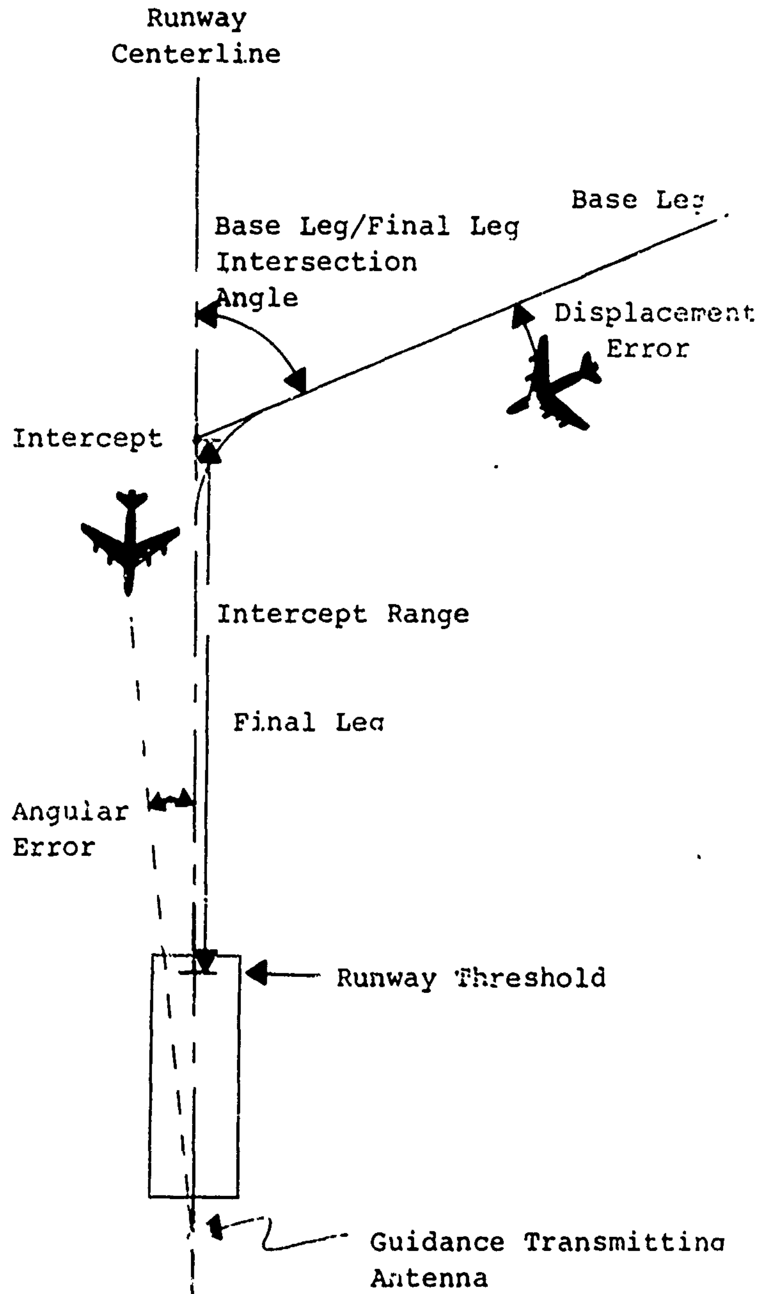


Figure 2.1.3-1 Curved Approach Geometry

the angle the aircraft must turn, the desired turn rate, and the pilot/controller turn anticipation time.

The normal aircraft/pilot delays and response characteristics described in Section 2.1.2 are in force throughout the turn maneuver. The glideslope of the base leg is assumed to be a value such that the curved path and base leg lie in the final leg glideslope plane.

Departures are considered to be controlled in the same manner as approaches (discussed in Section 2.1.2); that is, the pilot receives the same form of lateral guidance information as during an approach. Departures are therefore simulated the same as approaches with appropriate model parameter value changes.

A limited missed approach capability is within the operational limits of the curved path model. If a missed approach simulation is desired, a positive climb angle and missed approach range must be input. The aircraft will then climb out while flying down the localizer beam.

The curved path model consists basically of three separate models which are valid in different regions of the curved approach geometry as illustrated in Figure 2.1.3-2. When the aircraft is operating in the base leg region of the curved approach path, then the base leg model shown in Figure 2.1.3-3 is used. Within the turning region, the turning model shown in Figure 2.1.3-4 is valid. After the aircraft has completed the turn, the nominal model shown in Figure 2.1.2-4 is valid.

The curved path system model is capable of simulating IFR operations for CTOL or STOL aircraft operating on CTOL or STOL runways with either an ILS (Category I or Category II) or a VOR guidance system. Arrivals can be simulated on either straight-in approach paths or three-dimension general curved paths. Departures and missed approaches may also be simulated, but only on straight paths. The curved path model may be used as an analysis tool for studying curved approaches, departures, and missed approaches.

The curved path model has been programmed in FORTRAN IV and the source listing, flow charts, and operating instructions are contained in the User's Manual.

Multiple Aircraft/Runway Model

The multiple aircraft/runway model may be used to study the effects of longitudinal separation on lateral safety requirements for parallel/non-parallel, CTOL/STOL, and independent/dependent final approaches or departures to

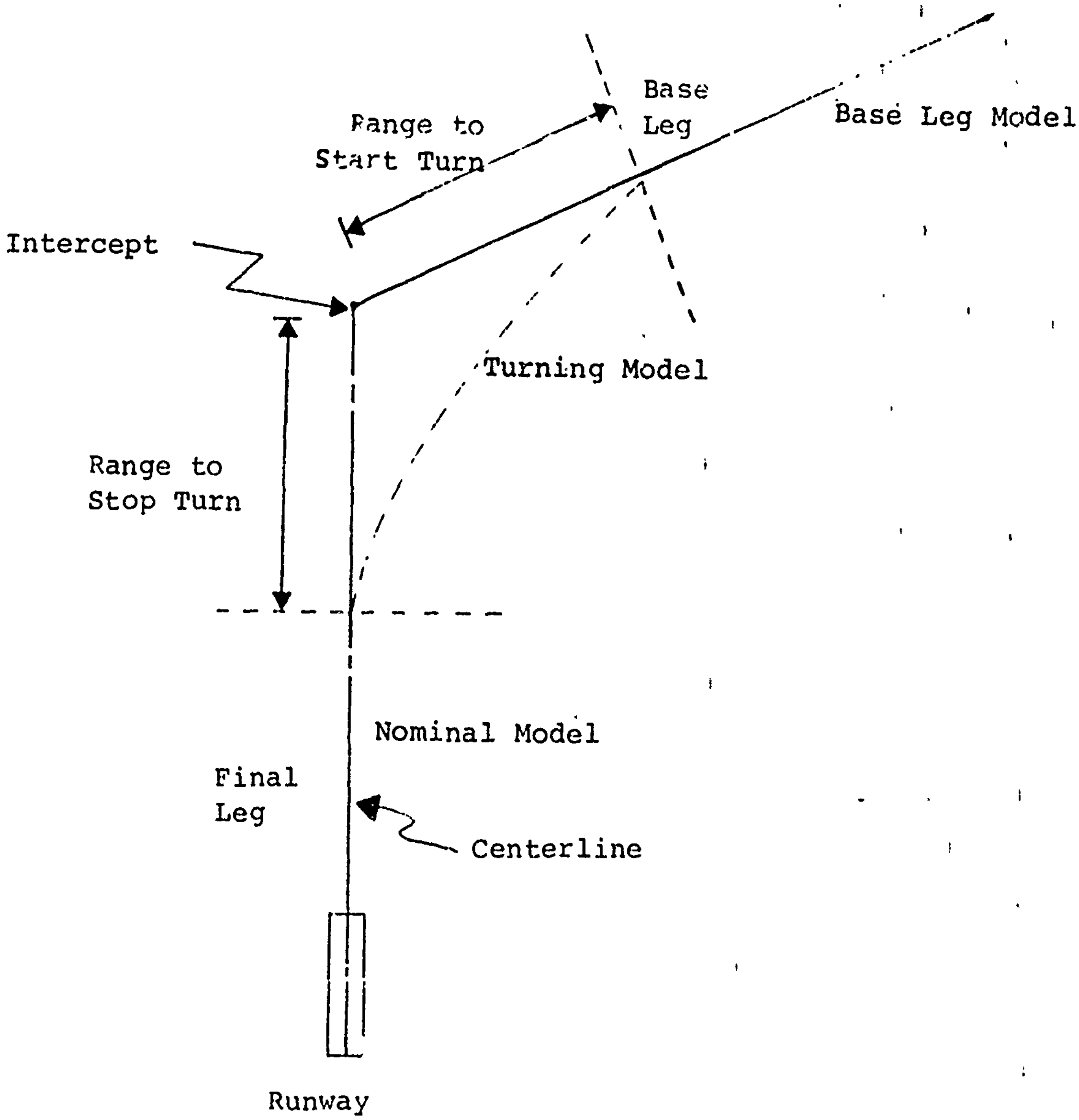


Figure 2.1.3-2 Curved Model Regions of Validity

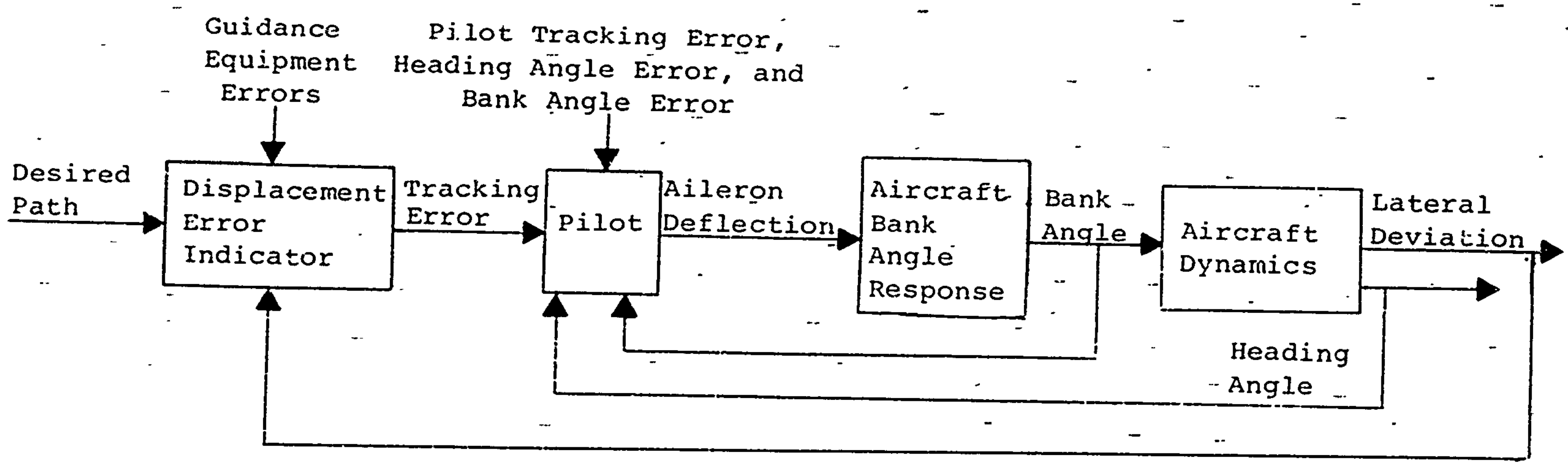


Figure 2.1.3-3 Base Leg Model

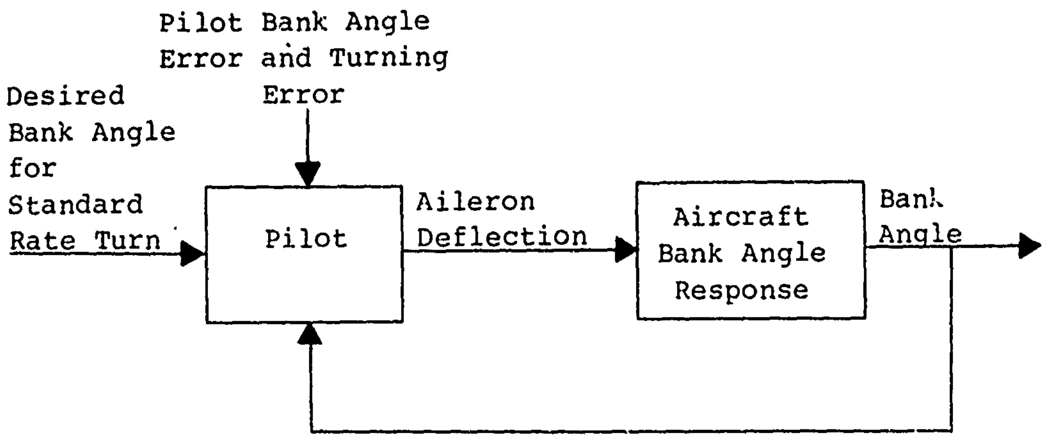


Figure 2.1.3-4 Turning Model

or from two parallel or skewed CTOL and/or STOL runways. Both CTOL and STOL type aircraft may be simulated approaching or departing either of the two runways.

In order to study parallel and non-parallel runway configurations a two runway model is required. By using two runways the following configurations may be studied: parallel runways of any lateral separation and threshold displacement; non-parallel runways; and CTOL/STOL or mixed operation runways. The possible parallel runway configurations are indicated in Figure 2.1.3-5. In all discussions Runway 1 is the primary runway, and Runway 2 is the secondary (displaced, skewed, STOL, etc.) runway. Non-parallel runway configurations are shown in Figure 2.1.3-6. Runway 2 may have its centerline at any angle within (and including) ±90° relative to the Runway 1 centerline. All critical approach operations may be studied using only two runways.

Independent and dependent operations may be simulated using only four aircraft (two per runway) with appropriately selected velocities and approach path locations. The influence of longitudinal speed and longitudinal separation on separation safety standards may thus be studied.

These assumptions have been used to develop the system model shown in Figure 2.1.3-7 which simulates four aircraft flying approaches (or departures) to two separate runways. The multiple aircraft/runway model outputs pertinent aircraft parameters including: relative velocities of all aircraft, the relative longitudinal separation of all aircraft measured in ground range, and the coordinates of all aircraft.

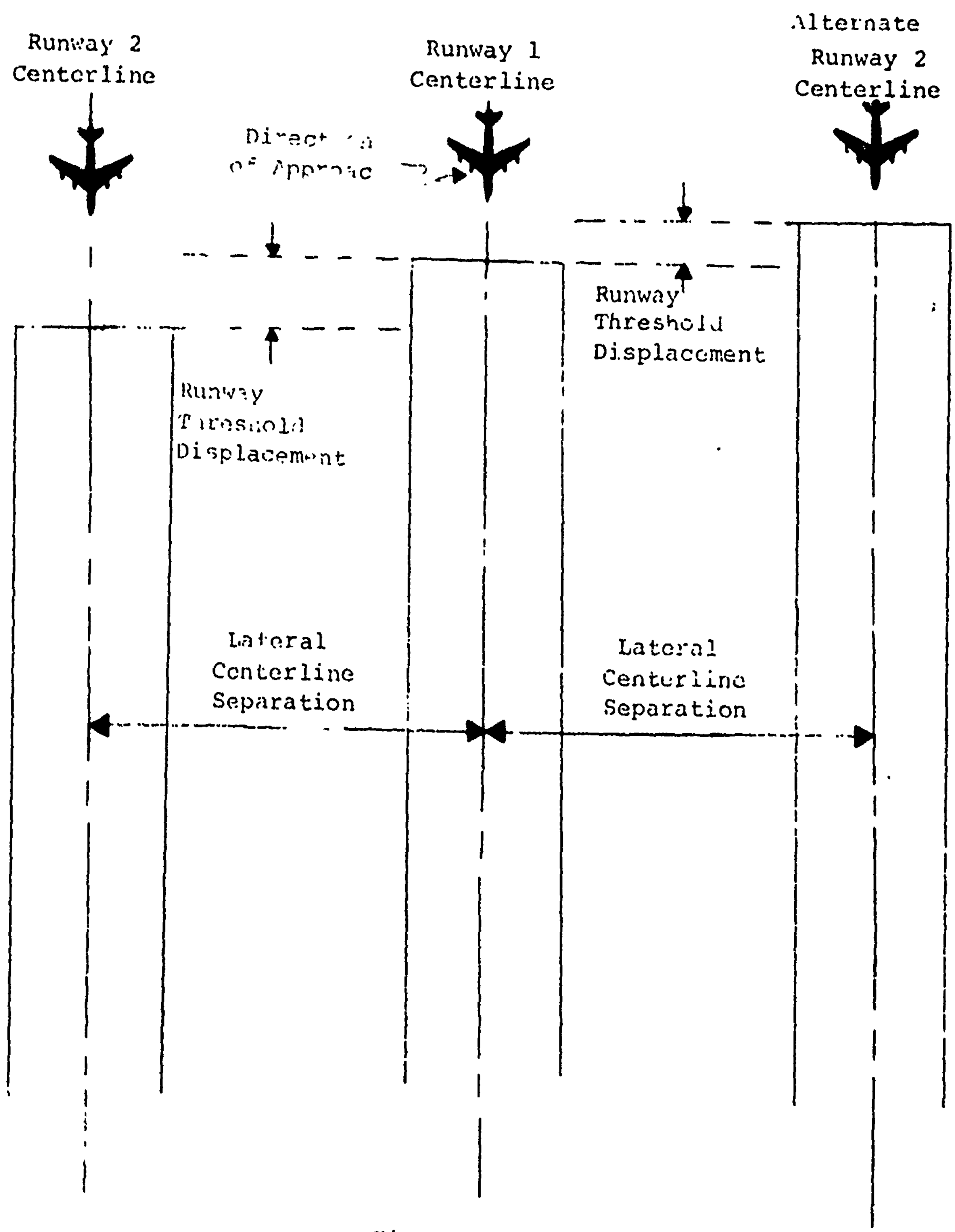
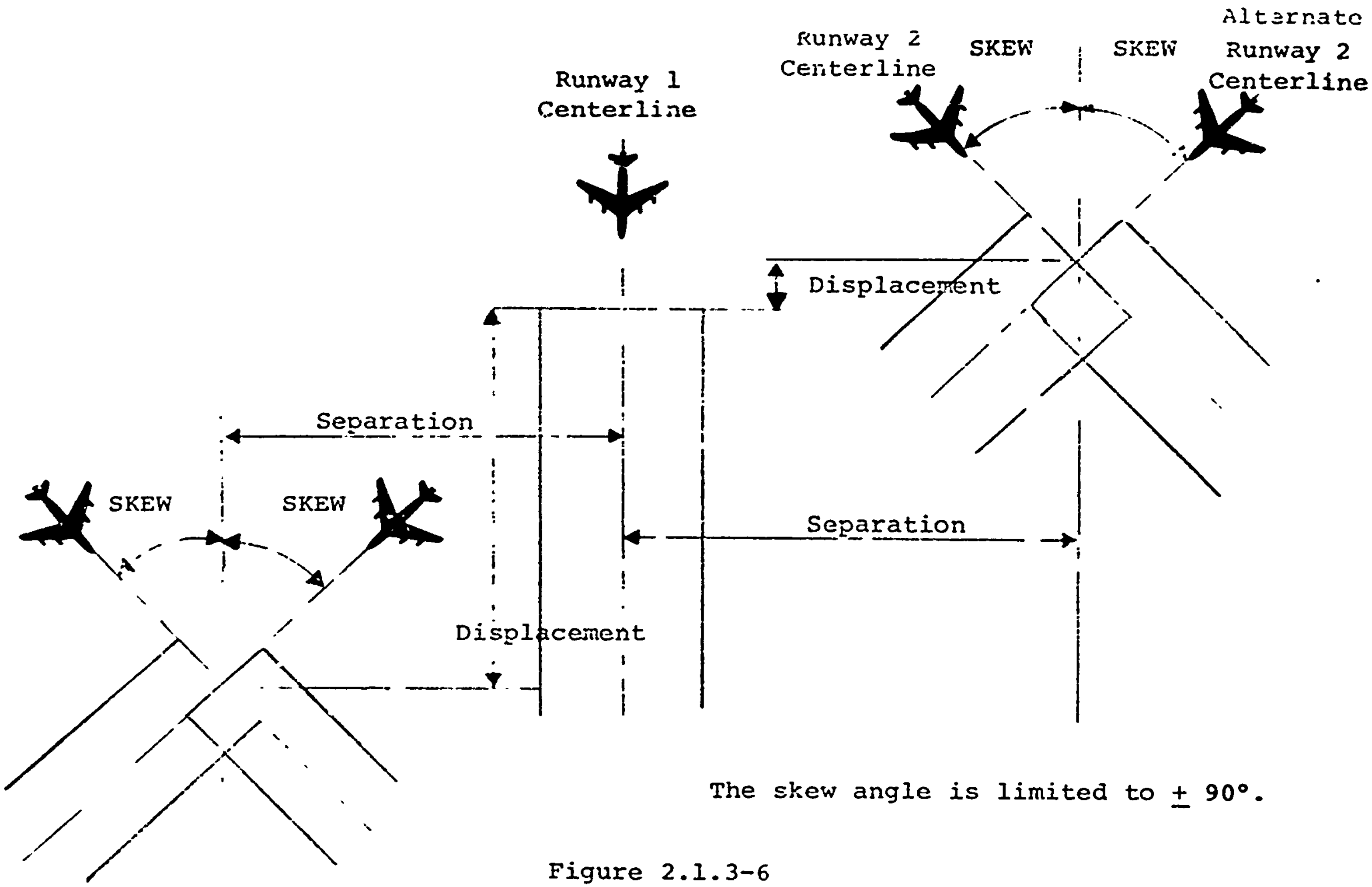


Figure 2.1.3-5
Multiple Aircraft/Runway Model
Possible Parallel Runway Configurations



The skew angle is limited to ± 90°.

Figure 2.1.3-6

Multiple Aircraft/Runway Model

Possible Skewed Runway Configurations

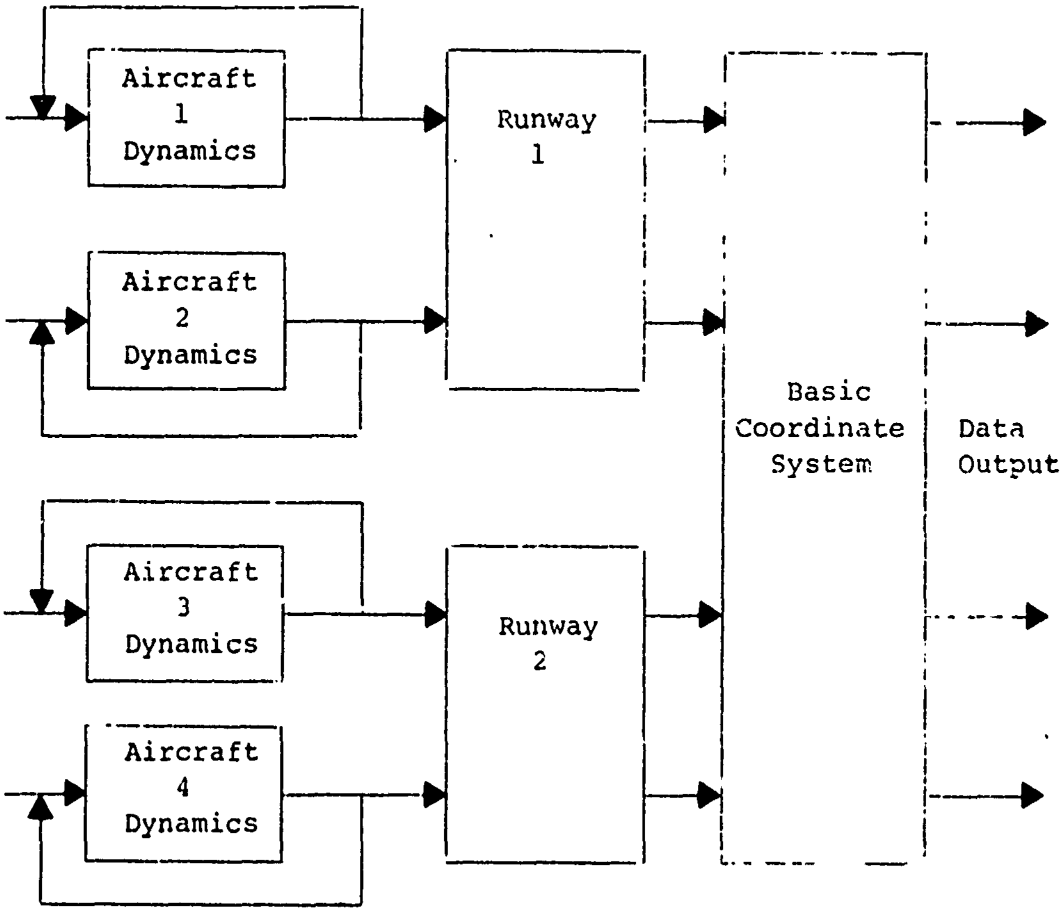


Figure 2.1.3-7 Multiple Aircraft/Runway Model Block Diagram

The multiple aircraft/runway model may be used for the analysis of (a) parallel arrival runways, (b) runways used for both arrival and departure operations, (c) multiple runway configurations; and includes longitudinal separation and lateral deviations for (a) CTOL and CTOL/STOL independent parallel runway operations, (b) CTOL and CTOL/STOL dependent, parallel operations, (c) independent CTOL/STOL non-parallel runway configuration operations, and (d) CTOL/STOL dependent non-parallel runway configuration operations.

The multiple aircraft/runway model has been programmed in FORTRAN IV and the source listing, flow charts, and operating instructions are contained in the User's Manual.

2.1.4 ERROR DEFINITION

Errors are inherent in every electronic and mechanical system. These errors are, in fact, the accumulation of errors from every component related to the entire system. The errors which are defined include the following six systems:
(1) VHF Omnidirectional Range Receiving Equipment,
(2) VHF Omnidirectional Range Transmitting Equipment,
(3) Instrument Landing Systems Receiving Equipment, (4) Instrument Landing Systems Transmitting Equipment, (5) Airport Surveillance Radar Systems, and (6) Human Response and Judgment Errors.

In order to realistically predict actual events by modeling and simulation techniques, errors must be included in the model. Error parameters that are to be entered into the model must be well defined and correctly communicate actual conditions to the model. Figure 2.1.2-4 illustrates the location of the error inputs to the nominal system model.

When estimations of errors are to be made, much research must be done to define the errors and determine the reliability of the error estimations. The approach used to define the error estimations for the equipment errors is to obtain error data from equipment specifications and error analyses resulting from projects conducted to determine errors inherent in specific systems. The specific systems are standard equipment utilized by the aviation industry.

In studies of this nature where data is not available or where the parameters being considered are not observable, it is necessary to use inductive reasoning to estimate values or accuracies. Such is the case with the pilot induced errors of interpreting the instruments presenting heading, bank angle and localizer information. Certain pilot error estimations will be adjusted to fit measured distribution

data for specific approach systems. Since accurate estimates of human attitude errors do not exist, it is necessary to estimate these errors by observing measured data or by analyzing the instruments or indicators which the pilot must read in the localizer tracking task.

All error sources are assumed to be white gaussian noise sources. In the "white gaussian" terminology, the "white" indicates that the power spectral density is uniform over the entire frequency range. The term "gaussian" refers to the type of amplitude distribution. In many applications only one word, white, is used and the other restriction is thus implied. A discussion of this assumption is contained in Volume II of this report.

2.1.5 STATE EQUATIONS

The Fokker-Planck analysis requires, as input, the system model state equations, which describe the complete dynamics of the approach systems described in Section 2.1.3.1. Since all specific approach system models to be considered are represented by the same block diagram, one set of state equations apply to all approach system models. The state equations are derived for both the linear and nonlinear system models. Figure 2.1.2-4 is the block diagram of the system model from which the state equations are derived.

SECTION 2.2

FOKKER-PLANCK DEVELOPMENT

One of the primary objectives of the Lateral Separation Study is to determine probabilities of collision between aircraft approaching parallel runways under IFR conditions. Prior to determining the probability of collision, a description of the distribution of lateral errors is needed. The Fokker-Planck equation is an analytical tool used in the Lateral Separation Study as a method to determine the distribution of lateral errors. In essence, the Fokker-Planck equation utilizes the dynamics of the system to predict how the shape of the distribution changes with range, provided an initial distribution is furnished as input to the Fokker-Planck equation. The system model described in the preceding section serves to input the system dynamics to the Fokker-Planck analysis. As shown in Figure 2.2-1, the system model and a description of the initial distribution of lateral errors are the only inputs necessary in the Fokker-Planck analysis. The Fokker-Planck equation is then solved on a digital computer, and the resulting solution is the distribution of lateral errors desired at any particular range from touchdown.

The Fokker-Planck equation has been described as the conservation of probability in that no matter how the shape of the distribution changes with time, the area under the curve is always equal to unity; i.e., the areas under the two curves shown in Figure 2.2-1 are always equal to unity.

The development of the Fokker-Planck equation occurred in two major stages:

(a) reduction of the system model, and
(b) the Fokker-Planck implementation for the reduced system model.

A brief description of these development stages is provided in the following paragraphs. The complete mathematical analysis associated with each stage is given in Volume II of this report.

The nonlinear version of the system model discussed in Section 2.1.2 represents the most accurate model developed in the Lateral Separation Study for an instrument landing approach system. Theoretically, the Fokker-Planck equation can be applied to a system of any finite order. However, limitations on computer memory and available computer time necessary for solving the Fokker-Planck equation require a lower order system model. Therefore, in order to apply the Fokker-Planck equation, it was necessary to simplify this model.

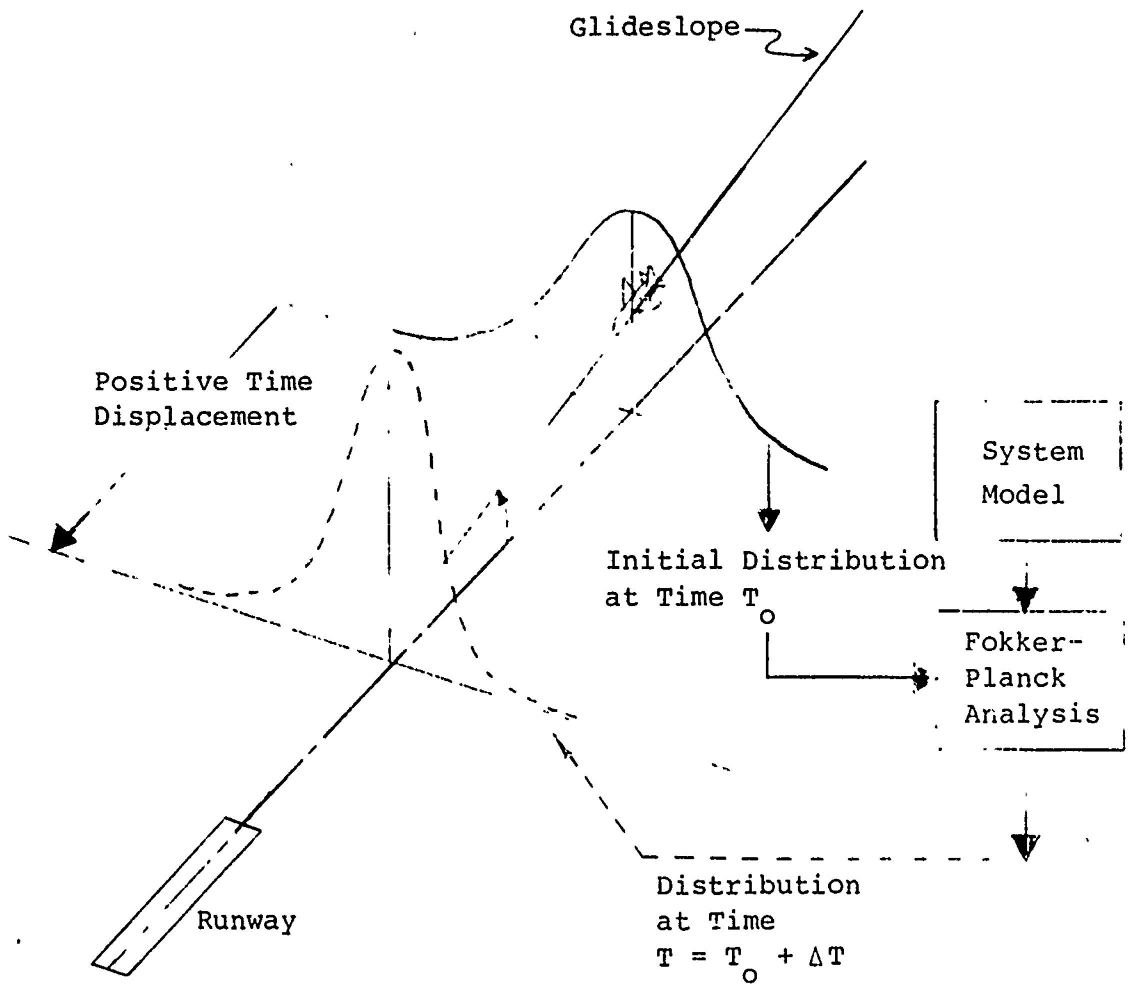


Figure 2.2-1 Fokker-Planck Method of Propagating a Distribution

The first step in simplifying the system model was accomplished by replacing the nonlinear portions of the model with accurate linear approximations. The resulting linear model was reduced to a second order system. The model linearization and reduction were verified by three separate analyses:

(1) a Monte Carlo simulation, which verified that the lateral distribution statistical response of the original nonlinear model accurately approximates the linearized model statistical response,

(2) a time response analysis, which verified that the lateral deviation time response of the original nonlinear model accurately approximates the linear reduced model response, and

(3) a root locus analysis, which verified that the original system could be accurately approximated with a second order system.

The reduced second order model represents the system model on which the Fokker-Planck analysis is based. The Fokker-Planck equation was developed for this model and then implemented for solution on a digital computer. The development and implementation is described in detail in Volume II. A checkout and verification of the Fokker-Planck solution is also presented in Volume II.

SECTION 2.3

MEASURED DISTRIBUTIONS

In an effort to define the distribution of lateral, vertical, and longitudinal errors for various approach systems, data in the form of trajectory information has been collected at several airports. Organizations that have collected data include Resalab and the FAA.

Since the measured distribution data has been derived from a finite number of samples, only certain reliable information is available from this data. Generally, the sample size is sufficient to warrant accurate estimates of the mean and standard deviation of the data; however, in some cases, the sample size is too small to accurately estimate the standard deviation. The sample size is generally not sufficient to accurately determine the shape of the distribution, particularly in the region of the tails. The data is available only at discrete points in range. Due to these limitations on the measured distribution data, it is necessary to utilize the Fokker-Planck technique to generate the probability density function for use in the probability of collision determination. Where no measured data exists (longitudinal), the distributions were derived, based on reasonable assumptions.

The measured distribution data was utilized in this study for three reasons:

1) to verify that the models, as formulated, are good representations of the actual systems (Sections 2.4 and 2.5),
2) to provide the initial distributions for the various techniques utilized to generate the probability density functions (Section 2.5), and
3) to provide vertical error distributions for use in the probability of collision determination (Section 2.6).

The lateral, vertical, and longitudinal measured distributions for the systems listed in Table 2.3-1 are required. Measured distribution data is available for all of the systems in Table 2.3-1 with the exception of the system specified for the longitudinal distribution. In this case, the distribution was derived, based on operational procedures.

The resulting distributions and comments on the validity of the data for each of the required systems are discussed in Volume II of this report (Section 3.1) and are presented in Appendix E of Volume II.

Table 2.3-1 Required Measured Distributions

Distribution	System
Lateral	FC-ILS-INOM-CTOL* FC-ILS-I-CTOL FC-ILS-II-CTOL BC-ILS-I-CTOL VOR-CTOL FC-ILS-I-STOL
Vertical	FC-ILS-I-CTOL FC-ILS-I-STOL
Longitudinal	FC-ILS-I-CTOL

*Nominal Measured Distribution Data

Most of the data collected prior to this time has been on front course ILS approaches. It is also necessary to study back course approaches since it is not uncommon to have the front course of the ILS systems on parallel runways oriented in opposite directions. This study considers the possibility of conducting independent front course and back course operations on parallel runways. Another parallel approach combination that is studied is the VOR approach parallel with a front course approach. Since little data was available on the lateral errors of aircraft during a back course or VOR approach, additional data was collected. The techniques of data collection, reduction, and processing used by Resalab are briefly discussed below and are illustrated in Figure 2.3-1.

As shown in Figure 2.3-1, the precision approach radar (PAR) was used to determine and display the spatial position of the aircraft. The PAR display is photographed, thus recording the aircraft position.

The data reduction effort in this study was concerned with determining the lateral position data of approaching aircraft. This data was obtained from measurements made from the developed film using a microdensitometer. This microdensitometer was interconnected with a computer for transfer and preliminary processing of the data. The computer automatically punched the data on a paper tape which was read by a larger computer for further processing. The design and operation of the data reduction system considered three classes of

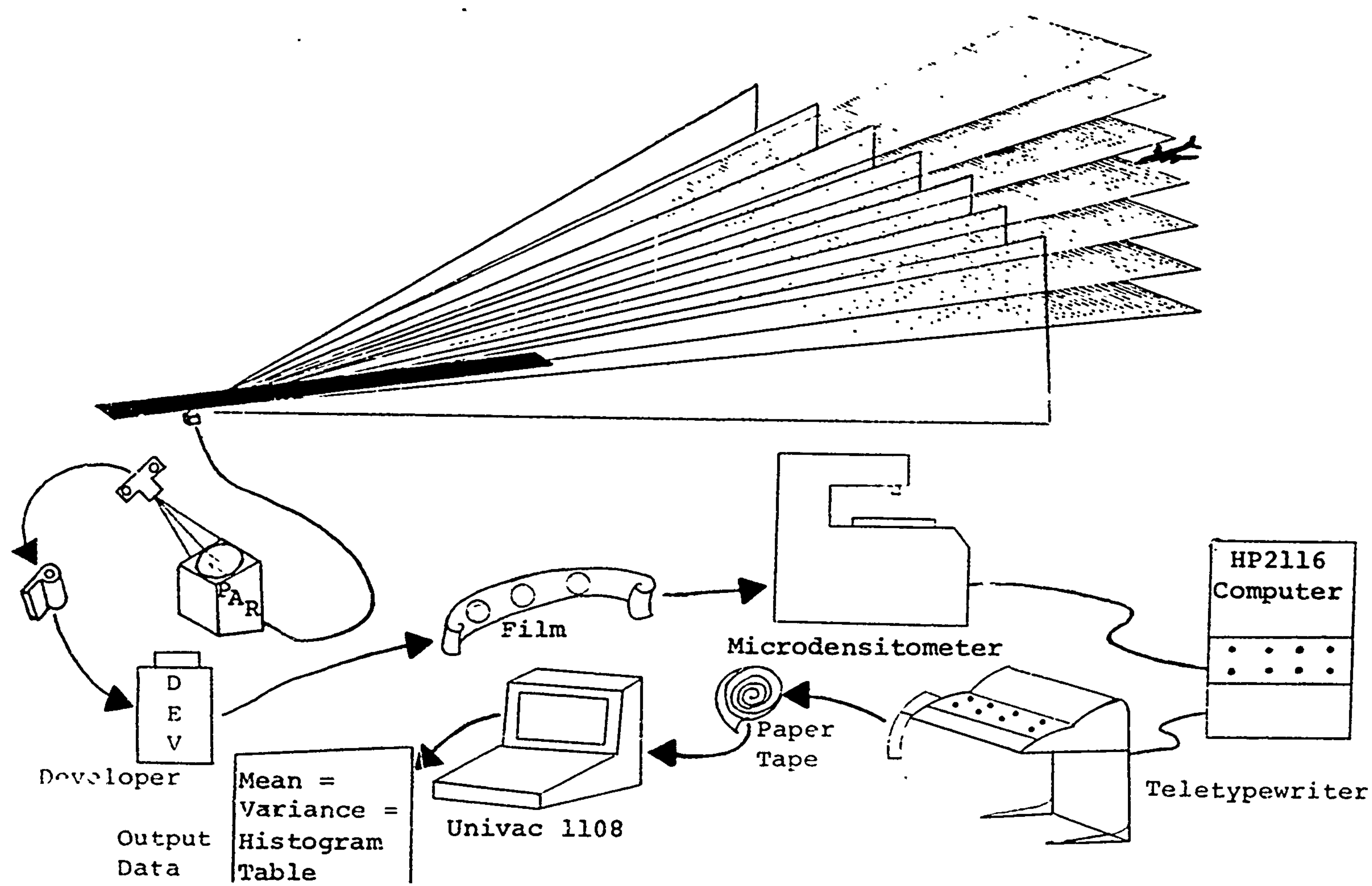


Figure 2.3-1 Data Collection, Reduction, and Processing Technique

error sources (measurement mistakes, systematic errors, and random human errors) and either eliminated or minimized them. A detailed analysis of the errors is contained in Volume II.

At specified ranges, data was processed to determine the arithmetical average (mean) and the standard deviation. In addition, a tabular presentation of histogram data was constructed. These data forms are consistent with the forms of data previously collected. The data collected by Resalab was then combined with data collected by the FAA.

As stated previously, it was necessary to determine measured distributions for the systems listed in Table 2.3-1. Measured distribution data can be summarized and presented in a variety of forms. The most advantageous presentation depends in part on assumptions concerning the characterization of the distribution shape and on the ultimate use of the data.

A common method of presenting measured distribution data is a tabular form of histogram or mean and standard deviation data. The systems from Table 2.3-1 that require distributions which are presented in this data form are:

FC-ILS-INOM-CTOL (Lateral)
FC-ILS-I-CTOL (Lateral)
FC-ILS-II-CTOL (Lateral)
BC-ILS-I-CTOL (Lateral)
VOR-CTOL (Lateral)
FC-ILS-I-CTOL (Vertical)

Where the processing of the published data has presumed gaussian distributions, these assumptions are maintained. Specifically, the systems of Table 2.3-1 for which gaussian distributions have been assumed are the following:

FC-ILS-I-STOL (Lateral)
FC-ILS-I-STOL (Vertical)

When the data is presumed to be distributed according to the gaussian distribution laws, the entire distribution is completely described by the mean and variance.

In the consideration of dependent parallel IFR operations for CTOL aircraft, it was necessary to determine the longitudinal location distribution about a nominal longitudinal location. Since no measured data of this type was available, it was necessary to make certain assumptions concerning this data for the FC-ILS-I-CTOL (longitudinal) system. The assumptions, resulting in a gaussian distribution, are discussed in detail in Volume II, Section 2.3.

The resulting combined data must be checked carefully to verify that the characteristics of one locale induced by traffic rate or geography do not bias the data. Some of the

possible local characteristics include turn-on range and turn-on direction. The specific local characteristics pertinent to each specific set of measured distribution data, the concept of adequate sample size, ground proximity, simulated versus actual IFR conditions, assumed distributions, and their effects, are discussed in Volume II.

SECTION 2.4

NOMINAL MODEL VERIFICATION AND SENSITIVITY ANALYSIS

In any simulation or modeling study, it is necessary to verify that the model is a good representation of the physical system. The most logical approach is to compare observed quantities from the physical system to the quantities predicted by the simulation. If a good comparison is observed, the system model is said to be verified.

This procedure was used to verify the instrument landing approach system nominal model discussed in Section 2.1.2. Three different analyses were used to verify the model - time response analysis, frequency response analysis, and statistical response analysis. The analyses are accomplished by fitting the nominal system model to a set of data hereafter referred to as the nominal measured distribution data (discussed in Section 2.3)

To determine the sensitivity of pertinent model parameters and model errors on the system's lateral distribution; a sensitivity analysis is performed.

The time response analysis is performed using a deterministic system (with no errors). Using the nominal model parameters, the time response of each feedback loop of the nominal model is determined and verified by comparison to the expected response.

The frequency response analysis consists of a root locus analysis of each feedback loop in the nominal model. This analysis shows the system transient response and gain variation for each loop and provides a guideline to system stability for variations in gain values. The frequency response analysis also verifies the state equations used in the model.

The relative dominance of one pair of roots to another is determined by their respective locations on the root locus plot. When one pair of roots dominate, the system can be approximated by a second order system and concepts such as damping ratio and frequency can be evaluated from the root locus graph. The damping ratio, which can be calculated easily from both root locus graphs and time response graphs, indicates the stability of the system.

The root locus of the nominal system model shows that the system has a dominant pair of roots near the origin which indicates it can be approximated by a second order system. Furthermore, the root locus indicates an operating point which varies with range. This variation in the operating point corresponds to the variation of system sensitivity with range as expected in the physical system. In order to verify the system model state equations, the system response characteristics predicted by a root locus analysis are compared to those characteristics obtained by integrating the state equations. The damping ratio and frequency that are calculated from the time response obtained by integrating the state equations compare favorably to the values predicted by the root locus.

In a similar manner, the root locus is obtained for the heading and bank angle feedback loops and the operating points of the nominal system are investigated.

The statistical response analysis describes the method used to fit the nominal model to the nominal measured distribution data and determines certain parameter values, errors, and initial state distributions.

The nominal model parameters and errors were discussed earlier in Sections 2.1.2 and 2.1.4; however, due to the nature of some of these parameters (primarily those due to pilot attitude and pilot errors), it is necessary to fit the model to measured field data to get better estimations for these parameters.

This analysis is conducted by considering the variance propagation of the linear model with gaussian inputs. The mean and variance of the response of a linear system with gaussian input distributions give a complete statistical description of the process, because the system output is also gaussian.

In order to determine more accurate estimates for the parameters in question, nominal measured distribution data was matched by the statistical response of the linear nominal model with gaussian input. The values are adjusted, within reasonable bounds, from their original estimates, and their effects on the lateral deviation distribution are determined. By observing these effects, reasonable adjustments are made to the pertinent model parameters until an acceptable fit, shown in Figure 2.4-1, is obtained.

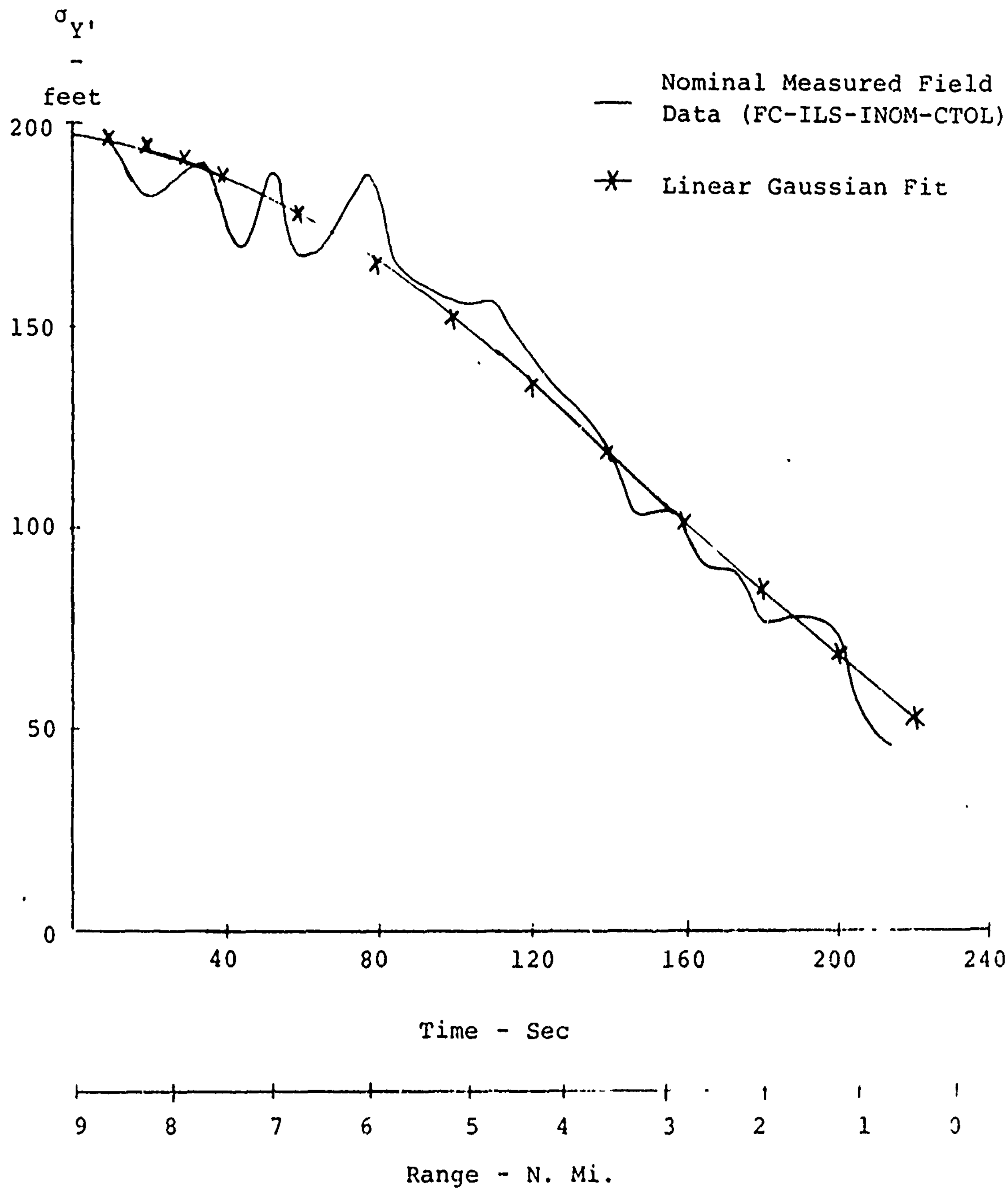


Figure 2.4-1 Nominal Model Fit to Nominal Measured Distribution Data

The purpose of the sensitivity analysis is to identify the effects of selected model parameters and model errors on the lateral distribution of the approach system. The sensitivity analysis is performed by utilizing the nominal system model discussed in Section 2.1.2, with specific initial conditions, as the reference condition. The system parameter sensitivity analysis, performed by utilizing a deterministic model, is used to find the sensitivity coefficients of the lateral deviation. The system error sensitivity analysis, utilizing a variance propagation technique, determines the sensitivity coefficients of the lateral distribution standard deviation. The pertinent parameters and errors are varied a specified amount about the reference condition and the resulting lateral deviations are observed. The sensitivity coefficients are determined from this data and illustrate the sensitivity of the lateral deviation or lateral distribution standard deviation to system parameters or system errors about the reference condition.

SECTION 2.5

PROBABILITY DENSITY FUNCTIONS AND NORMAL OPERATING ZONES

A positional error probability density function (PDF), as utilized in this study, is a statistical description of the errors about an "ideal track". It is defined for a composite set of aircraft flying the final leg of an instrument approach under IFR conditions. A complete three dimensional statistical description of these errors is required to aid in the generation of data necessary to determine minimum runway spacings. For this reason, the positional error probability density space consists of three dimensions (lateral, vertical, and longitudinal).

The primary dimension utilized in the lateral separation criteria determination is the lateral dimension. For this reason, lateral approach system models are developed which accurately generate the lateral PDF for the required approach systems. Development of these models is accomplished by adapting the nominal system model, discussed in Section 2.1 and verified in Section 2.4, to the measured distribution data from Section 2.3. This process is discussed in Section 2.5.1.

One purpose of this section is to describe the generation of the PDF's required in the probability of collision determination (Section 2.6) and in the NOZ determination. The generation of these PDF's is discussed in Section 2.5.2. This discussion is divided into three parts: lateral, vertical, and longitudinal PDF's. The method for generating the required lateral PDF's utilizes the Fokker-Planck equation (Section 2.2) with the lateral approach system models discussed in Section 2.5.1. The vertical error PDF's are determined directly from the measured distribution data from Appendix E in Volume II. The longitudinal error density is determined from an assumed constant velocity error distribution from Section 2.3.

A second purpose of this section is to discuss the generation of the required normal operating zones (NOZ) to be used in the determination of minimum runway spacings. The generation of the NOZ is discussed in Section 2.5.3 for approach systems in general and for CTOL/STOL skewed operations.

2.5.1 LATERAL PROBABILITY DENSITY FUNCTION MODELS

Before a lateral probability density function can be generated for a particular approach system, it is necessary to develop a model which accurately simulates the dynamics of that approach system. Furthermore, it is necessary to derive

the state equations from that model to be incorporated into the Fokker-Planck equation to allow the PDF to be generated. This section is a discussion of the method utilized to develop the approach system models listed below.

1. Front Course-ILS-Category I-CTOL (FC-ILS-I-CTOL)
2. Front Course-ILS-Category II-CTOL (FC-ILS-II-CTOL)
3. Back Course-ILS-Category I-CTOL (BC-ILS-I-CTOL)
4. VOR-CTOL (VOR-CTOL)
5. Front Course-ILS-Category I-STOL (FC-ILS-I-STOL)

The nominal model discussed in Section 2.1 and verified in Section 2.4 must be adapted to the measured distribution data (from Section 2.3) for each of the approach system models before the lateral probability density functions can be generated. The procedure required to adapt a model to the measured data is summarized in Volume II, Section 2.5.1. The completion of this procedure results in a model and its corresponding Fokker-Planck equation with all system parameters, errors, and initial conditions specified. The Fokker-Planck equation is then used to generate the lateral positional error.

2.5.2 PROBABILITY DENSITY FUNCTION GENERATION

The total aircraft positional error space probability density function consists of three dimensions; lateral, vertical, and longitudinal. Separation of these dimensions is possible due to the physics of the lateral separation problem, as discussed in Section 2.1. The primary purpose for generating the three PDF's is the calculation of the probability of collision values for the various required approach systems, operations, and runway spacings discussed in Section 2.6. A secondary reason for determining the lateral PDF's is the determination of the locus of points termed the normal operating zone. The approach systems for which PDF's are determined, the PDF type, and methods of determination are included for each of the three dimensions in Table 2.5.2-1. The procedure for determining the probability density function for the lateral dimension is considered in Section 2.5.2.1. The vertical PDF generation is discussed in Section 2.5.2.2 followed by the longitudinal PDF generation in Section 2.5.2.3.

Once the distribution data is generated for the three dimensions, the probability of collision data may be calculated for all required conditions. The normal operating zones may also be calculated using the lateral error probability density functions.

Table 2.5.2-1

Probability Density Functions

Dimension	Approach System	PDF Type	Method of Determination
Lateral	FC-ILS-I-CTOL	Fokker-Planck Output	Fokker-Planck
	FC-ILS-II-CTOL	Fokker-Planck Output	Fokker-Planck
	BC-ILS-I-CTOL	Fokker-Planck Output	Fokker-Planck
	VOR-CTOL	Fokker-Planck Output	Fokker-Planck
	FC-ILS-I-STOL	Fokker-Planck Output	Fokker-Planck
Vertical	FC-ILS-I-CTOL	Gaussian	Measured Distribution Data
	FC-ILS-I-STOL	Gaussian	Measured Distribution Data
Longitudinal	FC-ILS-I-CTOL	Gaussian	Assumed Velocity Distribution

2.5.2.1 Procedure for Lateral Density Function Generation

It is necessary to generate lateral PDF's for the lateral approach systems listed in Table 2.5.2-1. The approach taken to generate the required PDF's utilizes the Fokker-Planck equation and the approach system models discussed in Section 2.5.1. The model block diagrams, parameters, errors, and initial conditions are presented in Volume II, Appendix G.

The procedure utilized to generate the lateral PDF's consists of four basic steps. The completion of this procedure results in a lateral PDF which is used in the probability of collision determination and in a NOZ determination.

The first step in the procedure is to determine the lateral deviation PDF to be used to initialize the Fokker-Planck equation at the initial range (turn-on range). The method to determine this PDF utilizes the modified Burgerhout PDF to fit the initial measured distribution data for the first four systems listed in Table 2.5.2-1. The FC-ILS-I-STOL (Lateral) system utilizes a gaussian fit to the initial measured distribution data. The statistical means for both the CTOL and STOL lateral PDF's were set to the extended runway centerline.

Step two of the procedure consists of selecting the appropriate model with its associated parameters, errors, and initial conditions and incorporating these values into the nonlinear state equations discussed in Section 2.1.5.

Next, in step three of the procedure, the nonlinear state equations are reduced to a set of linear second order state equations. The reduced state equations are then implemented into the Fokker-Planck equation. This equation is initialized using the initial lateral deviation PDF determined in the first step of this procedure. The lateral PDF is then generated by solving the Fokker-Planck equation.

Several items must be considered prior to the actual generation of the lateral error probability density data. First, the initial range and final range from touchdown must be selected and the corresponding PDF for the initial range calculated. The selection of these ranges is restricted only by model considerations. That is, the initial range must occur after the aircraft has completed turn-on and the final range must be selected at or before the point where the aircraft becomes VFR.

In addition to the initial and final range values, the delta range interval for the solution of the Fokker-Planck equation must be selected. A delta range interval of approximately 23.6 feet (.1 second at 140 knots) was selected to generate the lateral probability density functions. The primary reason for the choice of these range increments was to yield

accurate results for the total collision probability for dependent operations. Without the use of the Fokker-Planck equation, such range accuracy would not be possible since the measured data had range increments in the order of 2000 feet.

The grid spacing increment along the lateral axis, utilized in the computer solution of the Fokker-Planck equation, is based primarily on the accuracy required for collision probability determination and the lateral distribution at the initial range. The values selected for the five lateral approach systems were 38 increments approximately 174 feet in length which yielded a total lateral error coverage of approximately 3300 feet on either side of the runway centerline. Once this final parameter is selected, the Fokker-Planck equation is solved using a digital computer solution technique. The lateral error PDF data is presented in Volume II, Appendix H, at the initial range and other ranges required for the probability of collision determination for each of the systems.

2.5.2.2 Procedure for Vertical Density Function Generation

For the collision probability determination, the composite CTOL/STOL operations require a vertical dimension error PDF. This results from the fact the CTOL operation has a different glideslope (2.5°) than the STOL (7.5°) operation; and, therefore, the worst case assumption of vertical coincidence is not valid.

A gaussian vertical error PDF was selected for the vertical dimension. This type of distribution was selected due to the fact that one, there was no requirement to model the vertical dimension, and two, the measured data over range intervals of interest tested gaussian with only a few exceptions. The gaussian distributions were determined by using the measured error distribution data as the vertical error PDF. The measured data standard deviations were linearly interpolated to arrive at vertical distributions at the required range points for the two vertical systems indicated in Table 2.5.2-1.

The means for both the CTOL and STOL vertical PDF's were set to the glideslope value to reduce the problem of including system biases that were peculiar to the measured data collection sites. No attempt was made to include the non-symmetrical distribution effect which occurs near touchdown for either of the two systems. The vertical PDF data at selected ranges is presented in Volume II, Appendix H.

2.5.2.3 Procedure for Longitudinal Density Function Generation

The need for a longitudinal error density function was predicated by the requirement to determine probability of collision data for dependent operations. Thus, a longitudinal error density function was required for the FC-ILS-I-CTOL approach system. Using a velocity error standard deviation of 5 knots, a mean of 140 knots, and assuming a gaussian distribution, the longitudinal error probability density function was generated. The resultant longitudinal error distribution is also gaussian. The longitudinal error distribution is a time varying process in which the mean of the PDF travels at a constant velocity, and the standard deviation increases proportionately with time. This process describes a spreading longitudinal location error, which is expected for dependent operations as assumed in this study. It is assumed for dependent operations that at some range greater than the outer marker, the controller establishes a desired longitudinal separation between two aircraft approaching adjacent parallel runways and a nominal approach speed for the two aircraft. This range is assumed to be 9 nmi, which corresponds to the approximate range at which the 1000 foot vertical separation is lost. The nominal approach speeds for the two aircraft are assumed equal. It is further assumed that once the desired longitudinal separation and nominal approach speed have been established, the controller no longer controls the process; i.e., no real-time velocity or location control occurs after the desired separation and speeds are established. Thus, the longitudinal location error of aircraft flying with an assumed constant velocity error standard deviation would tend to increase with time. The resulting longitudinal PDF for the FC-ILS-I-CTOL system is presented in Volume II, Appendix H, at selected ranges.

2.5.3 NORMAL OPERATING ZONE DETERMINATION

The normal operating zone (NOZ) is defined as being a zone that contains either 68% or 95% of the operations. These percentage values correspond roughly to the 1σ and 2σ points respectively for a gaussian distribution function. Except for the STOL case, the lateral error distributions are non-gaussian; therefore, the percentage definition will be used for determining the normal operating zones. The procedure for determining the NOZ for the approach systems indicated in Section 2.5.1 is based primarily on the integration of the lateral error density functions for each of these systems. It is also necessary to determine the NOZ for CTOL/STOL skewed operations. The NOZ for this case is determined in a slightly different manner.

2.5.3.1 NOZ Determination for Approach Systems

The 68% and 95% NOZ's are determined for the approach systems by integrating the lateral error density functions as illustrated in Figure 2.5.3-1. The 68% and 95% points are calculated at specified range intervals along the approach. The loci of these points are two lines, symmetric about the runway centerline, which define the 68% and 95% NOZ respectively. At 5000 feet range from the runway for CTOL operations and at 1500 feet for STOL operations, the NOZ is defined by two lines parallel to the runway centerline as depicted in Figure 2.5.3-2. These points correspond to the approximate ranges at which the CTOL and STOL aircraft go VFR and the corresponding model becomes invalid. The 68% and 95% NOZ's for each of the systems listed in Section 2.5.1 are presented in Appendix A.

2.5.3.2 CTOL/STOL Skewed Normal Operating Zone

To determine the minimum runway spacing between CTOL/STOL skewed runways, the normal operating zone for STOL departures must be determined at the point of minimum separation between the CTOL runway extended centerline and the STOL nominal departure path. The geometry of the CTOL/STOL skewed configuration is illustrated in Figure 2.5.3-3. As shown in the figure, the point of minimum separation occurs within the curved portion of the nominal departure path. Due to the complexity of the task of generating the PDF for the curved path departure, the NOZ for this case is determined in a slightly different manner.

The basic approach to determine this NOZ is to utilize a model of the curved path dynamics of the departing STOL aircraft to perform a Monte Carlo simulation. The standard deviation of the lateral errors, measured from the nominal departure path, at the minimum separation point is determined from the Monte Carlo simulation. For this analysis, the 68% NOZ is assumed to be equal to σ_Y, and the 95% NOZ is assumed to be equal to $2\sigma_Y$.

The STOL nominal departure path is defined in Figure 2.5.3-3. The straight portion of the departure is followed until the aircraft reach an altitude of 400 feet; and at this point, the aircraft execute a standard rate turn. The initial distribution of the radius of curvature is also assumed to be gaussian. The standard deviation (93 feet) is assumed from the lateral PDF for an approach at the equivalent range. The results of the Monte Carlo simulation were the corresponding σ_Y and $2\sigma_Y$ values at the minimum separation point for skew angles

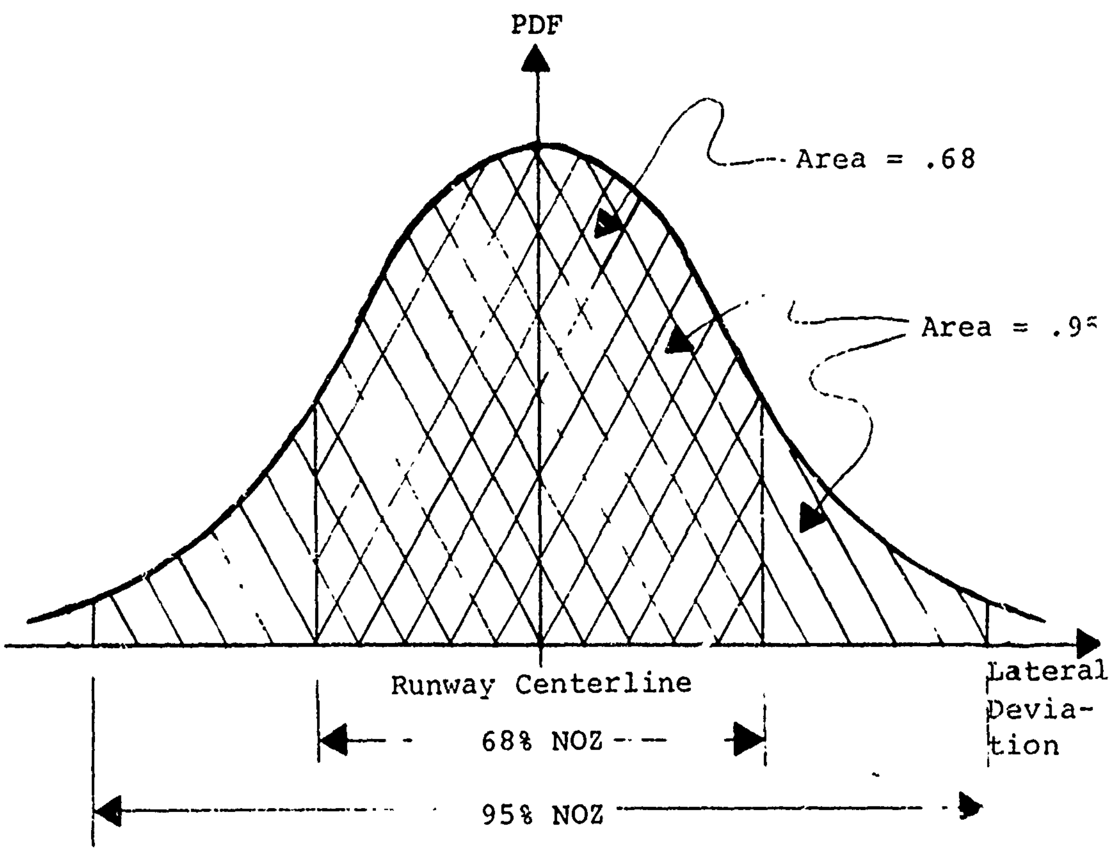


Figure 2.5.3-1 Normal Operating Zone Determination

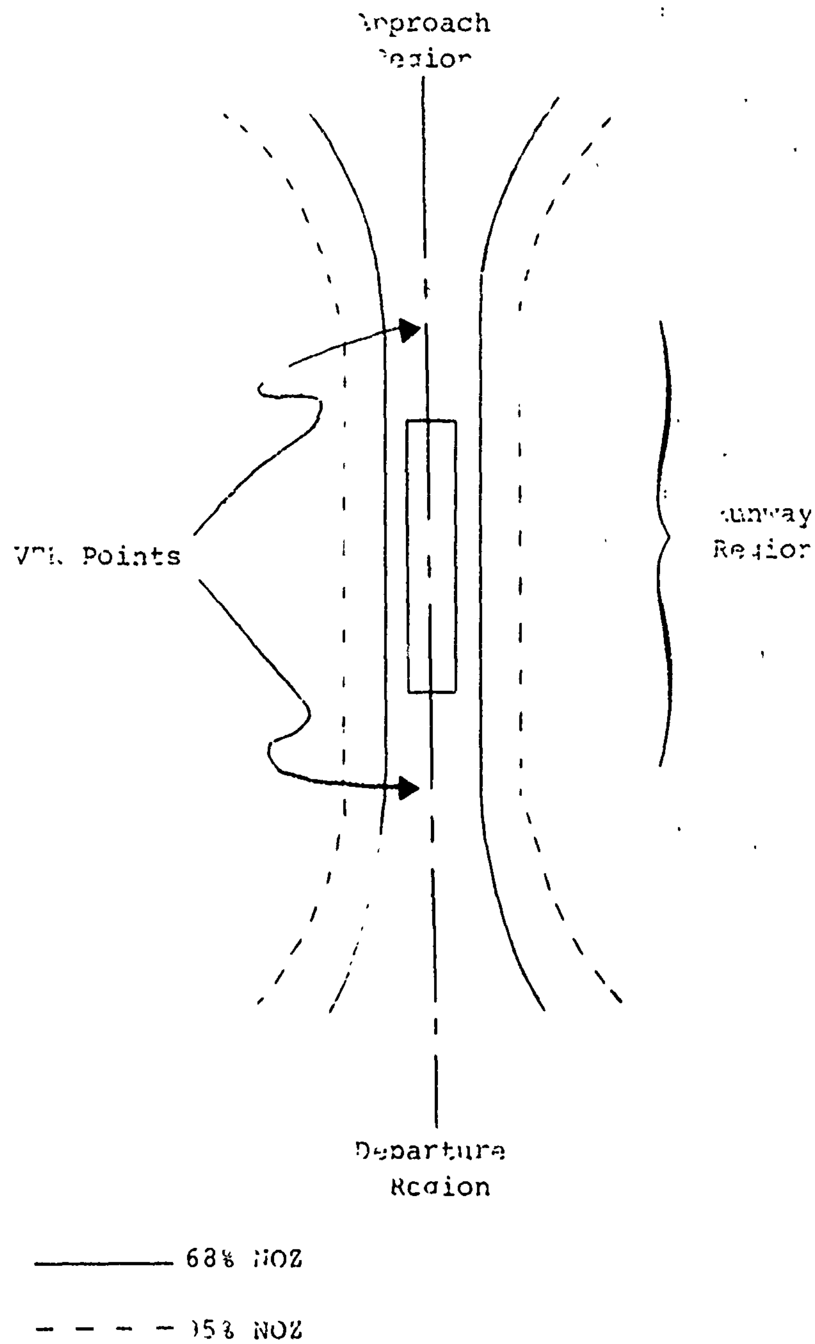


Figure 2.5.3-2 Normal Operating Zone

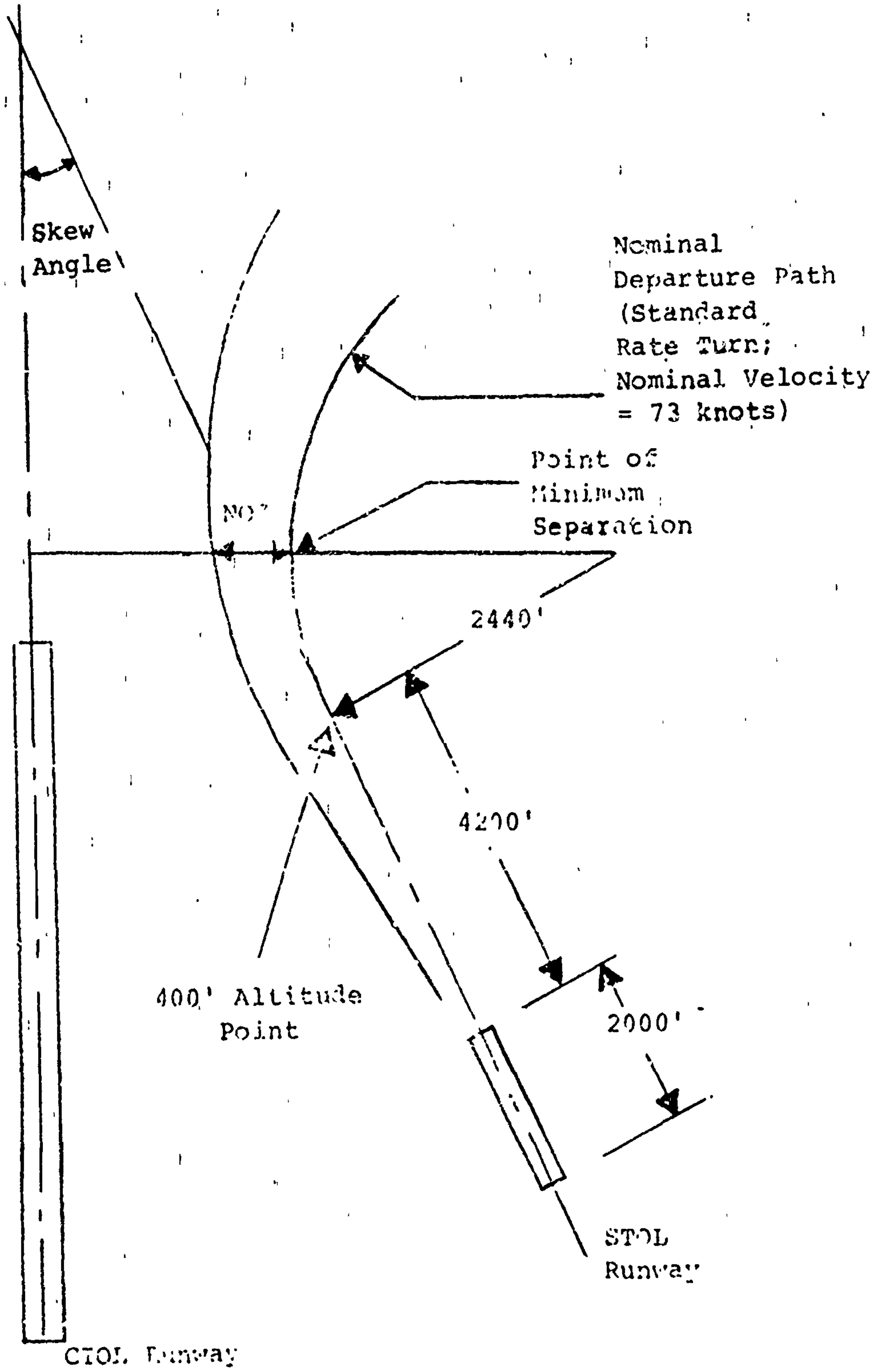


Figure 2.5.3-3 CTOL/STOL Skewed Geometry

of 10°, 20°, 30°, 40°, 50°, 60°, 70°, 80°, and 90°. The NOZ's resulting from this analysis are presented in Appendix A.

SECTION 2.6

PROBABILITY OF COLLISION

In order to reduce the present minimum spacing criteria between two parallel runways, a means of measuring the relative safety of two aircraft attempting to land on parallel runways is needed. This relative safety measure has been identified as the probability of collision in the Lateral Separation Study.

It is assumed throughout this analysis that the airspace requirements for a departure are no greater than an approach; therefore, the probability of collision models described in this section are based on approaches, and all subsequent results obtained are assumed to be equally valid for both departures and approaches.

The probability of collision between two aircraft approaching parallel runways is considered for the following cases:

(a) STOL/STOL independent operations
(b) CTOL/CTOL independent operations
(c) CTOL/CTOL dependent operations
(d) CTOL/STOL independent operations

The notation used above defines the aircraft and runway configuration for each of the parallel runways. For example, CTOL/STOL defines one runway as being a CTOL runway with CTOL aircraft as the primary user class and the remaining runway as a STOL runway with STOL aircraft as the primary user class. Independent operations refer to aircraft approaching parallel runways such that no controller intervention occurs for the purpose of ensuring longitudinal spacing between the aircraft. This does not prevent the controller from intervening in the event that one aircraft deviates outside the established normal operating zone. Dependent operations refer to a situation in which two aircraft approach parallel runways and at least one of the aircraft is subjected to controller intervention in an attempt to establish a longitudinal spacing between the approaching aircraft. It is assumed for dependent operations that at some range beyond the outer marker, the controller has established

(1) the desired longitudinal spacing between the two aircraft, and
(2) the nominal approach speeds for the two aircraft.

It is further assumed that once the spacing and approach speeds

have been established, the remainder of the approach is conducted without speed control.

Simplifying assumptions and a discussion of the general method of approach is presented in Section 2.6.1. A general discussion of assumptions associated with the probability of collision models for cases (a), (b), (c), and (d) above is then given in Sections 2.6.1.1, 2.6.1.2, 2.6.1.3, and 2.6.1.4, respectively.

The aircraft lateral, vertical, and longitudinal error probability density functions are discussed in Section 2.5 and presented in Appendix H of Volume II. These density functions are used in the generation of the required probabilities of collision as discussed in Section 2.6.2. Specific runway and approach system configuration for each of the above four cases are also discussed in Section 2.6.2. Results obtained from all combinations outlined in Section 2.6.2 are discussed in Section 3.2 and presented in Appendix B. The probability of collision results contained in Appendix B can be utilized in determining minimum runway spacing as described in Section 4.

2.6.1 ANALYTICAL DEVELOPMENT

Figure 2.6.1-1 represents the geometry and coordinate system upon which the general form of the probability of collision between two aircraft is based. As illustrated in the figure, d represents the separation between two aircraft approaching parallel runways. Since the value of d cannot be deterministically evaluated, the probability of collision as defined in the Lateral Separation Study is "the probability that the separation d between aircraft will be less than the wing span of either aircraft". The assumptions employed in developing a probability of collision model are different for each of the four cases mentioned in Section 2.6. Therefore, discussions of the assumptions associated with each case are presented independently in the remaining four sub-sections. Assumptions for each individual case always result in a worst case situation, i.e., the probability of collision model developed for a particular case represents the most conservative model for aircraft operating under normal conditions. A complete mathematical analysis of each model discussed is furnished in Volume II.

2.6.1.1 STOL/STOL Independent Operations

This section discusses the probability of collision between two STOL aircraft flying independent parallel approaches.

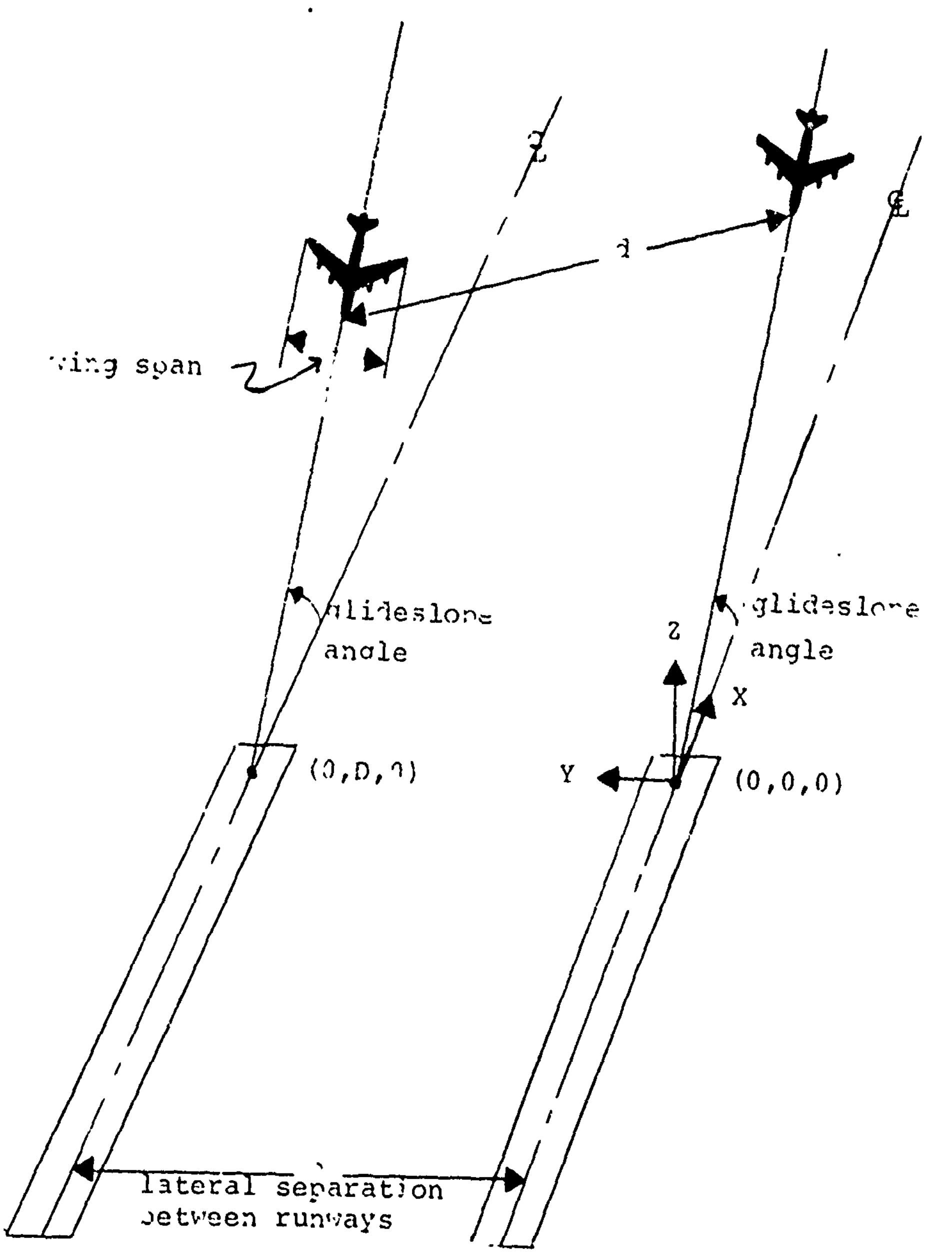


Figure 2.6.1-1 Probability of Collision Geometry

As illustrated in Figure 2.6.1-2, the runways are parallel and separated by D feet. The coordinate system is defined as in Figure 2.6.1-1; thus,

X_i aircraft$_i$ longitudinal position

Y_i aircraft$_i$ lateral position

Z_i aircraft$_i$ vertical position $i=1,2.$

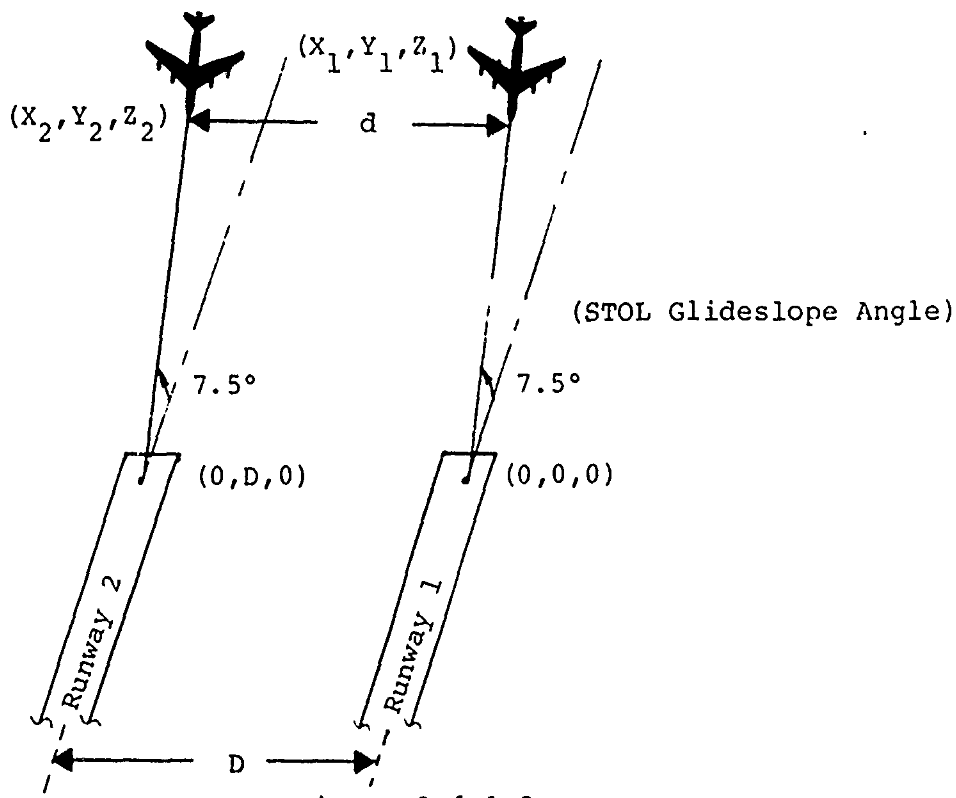


Figure 2.6.1-2

Probability of Collision Geometry for STOL/STOL Independent Operations

The analytical development presented in Volume II utilizes the following assumptions for STOL/STOL independent operations:

(i) longitudinal coincidence is maintained between the aircraft approaching adjacent runways; i.e., $X_1 = X_2$;

(ii) vertical coincidence is maintained between aircraft approaching adjacent runways; i.e., $Z_1 = Z_2$; and,

(iii) Y_1 and Y_2 are independent and normally distributed random variables , $N(\mu_1,\sigma_1^2)$ and $N(\mu_2,\sigma_2^2)$, respectively (Section 2.5).

The symbol $N(\mu_i,\sigma_i^2)$ indicates a gaussian distribution with a mean = μ_i and variance = σ_i^2 for i = 1, 2.

For STOL/STOL independent operations, the primary dimension of interest is lateral; therefore, a lateral distribution is utilized in the determination of the probability of collision. To assure a worst case condition, longitudinal and vertical coincidence are assumed; thus, no statistics are associated with these dimensions.

2.6.1.2 CTOL/CTOL Independent Operations

The probability of collision for CTOL/CTOL independent operations is discussed in this section, and the geometry on which the probability of collision is based is presented in Figure 2.6.1-3.

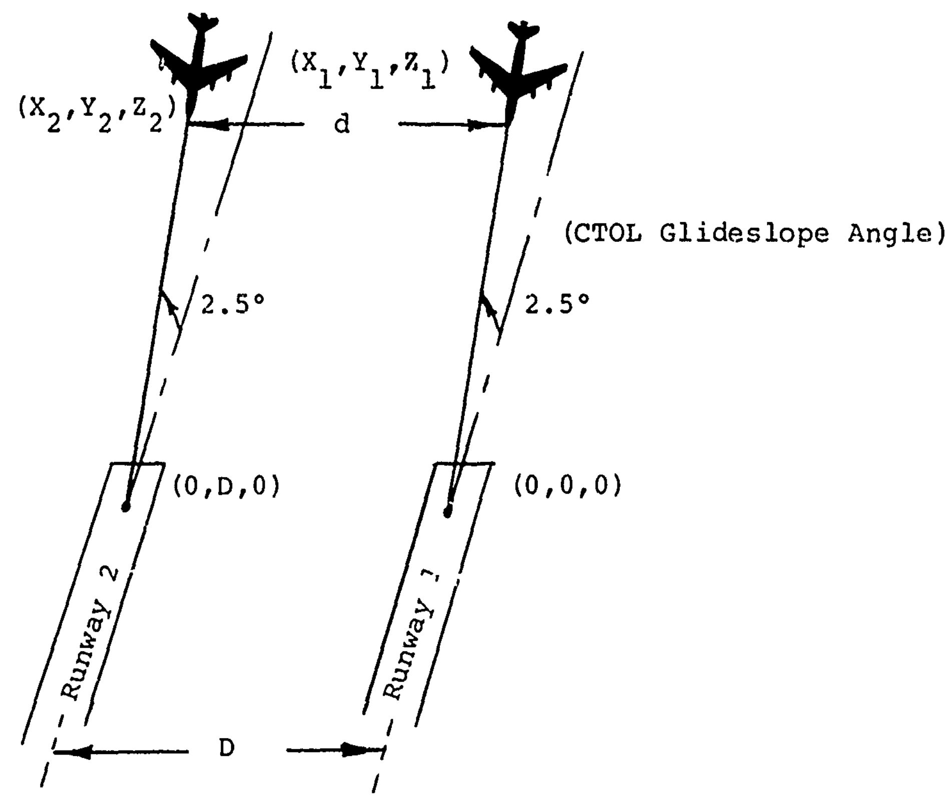


Figure 2.6.1-3
Probability of Collision Geometry for CTOL/CTOL Independent Operations

The analysis for CTOL/CTOL independent operations to parallel runways utilizes the following assumptions:

(i) longitudinal coincidence exists between aircraft approaching adjacent runways, i.e., $X_1 = X_2$;

(ii) vertical coincidence exists between aircraft approaching adjacent runways, i.e., $Z_1 = Z_2$; and,

(iii) Y_1 and Y_2 are independent random variables distributed according to the PDF's obtained from Appendix H in Volume II for FC-ILS-I-CTOL (Lateral), BC-ILS-I-CTOL (Lateral), and VOR-CTOL (Lateral).

As stated in Section 2.6.1, assumptions (i) and (ii) represent worst case conditions upon which the probability of collision model is based. A complete mathematical development of the probability of collision model based on the preceding assumptions is given in Volume II.

2.6.1.3 CTOL/CTOL Dependent Operations

The probability of collision for CTOL/CTOL dependent operations is discussed in this section. Figure 2.6.1-4 represents the geometry associated with CTOL/CTOL dependent operations. It should be noted that, unlike preceding cases, the coordinate system on which the probability of collision in this section is based assumes that longitudinal position is measured along the glideslope plane and not along a horizontal

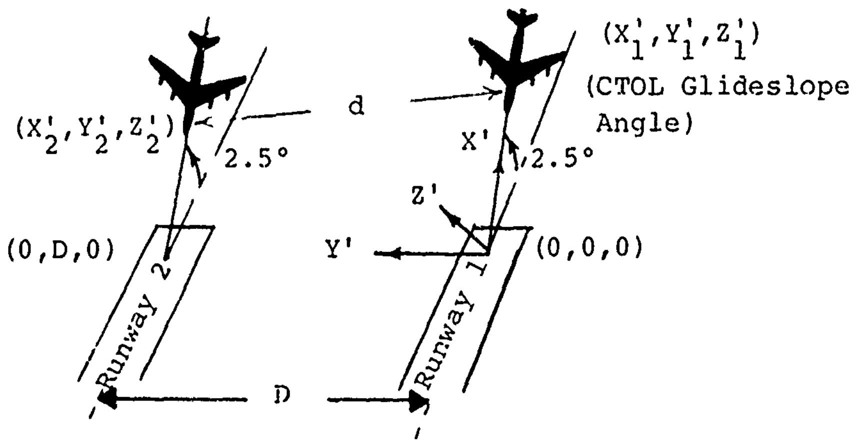


Figure 2.6.1-4

Probability of Collision Geometry for CTOL/CTOL Dependent Operations

extension of the runway centerline. Therefore, vertical position is measured perpendicular to the glideslope plane;

i.e., positive or negative vertical errors imply that the aircraft is above or below the glideslope plane, respectively. The lateral or Y'-axis is orthogonal to the X'Z'-plane with the origin of the coordinate system located at the touchdown point of runway 1.

The following assumptions regarding CTOL/CTOL dependent operations represent a worst case situation on which the probability of collision model is based:

(i) approaching aircraft are assumed to lie in the glideslope plane, i.e., $Z_1' = Z_2' = 0$,

(ii) velocities of aircraft 1 and 2 are assumed to be normally distributed, $N(\mu_1,\sigma_1^2)$ and $N(\mu_2,\sigma_2^2)$, respectively (from Section 2.3); and,

(iii) Y_1' and Y_2' are assumed to be independent random variables governed by the respective densities determined from the Fokker-Planck equation (from Section 2.5).

For CTOL/CTOL dependent operations, the primary dimensions of interest are lateral and longitudinal; therefore, lateral and longitudinal distributions are utilized to determine the probability of collision. To assure a worst case condition, the aircraft are assumed to remain in the glideslope plane ($Z_1' = Z_2' = 0$); thus, no statistics are associated with the vertical dimension. The analytical development of the probability of collision model based on the preceding assumptions is furnished in Volume II.

2.6.1.4 CTOL/STOL Independent Operations

The geometry associated with the CTOL/STOL independent operations is identical to the CTOL/CTOL independent operations case with one exception - the glideslope angle for the STOL approach is 7.5 degrees as indicated in Figure 2.6.1-5.

Since the approach is an independent operation, longitudinal coincidence ($X_1 = X_2$) is assumed to assure a worst case condition as in the independent approach cases discussed in Sections 2.6.1.1 and 2.6.1.2. Other assumptions utilized are:

(i) vertical positions, Z_1 and Z_2, of aircraft 1 and 2 are normally distributed, $N(\mu_1,\sigma_1^2)$ and $N(\mu_2,\sigma_2^2)$, respectively (Section 2.5);

(ii) Y_2 is a random variable distributed according to the density output determined from the Fokker-Planck equation (Section 2.5); and

(iii) Y_1 is distributed $N(\mu_{Y_1},\sigma_{Y_1}^2)$ (Section 2.5).

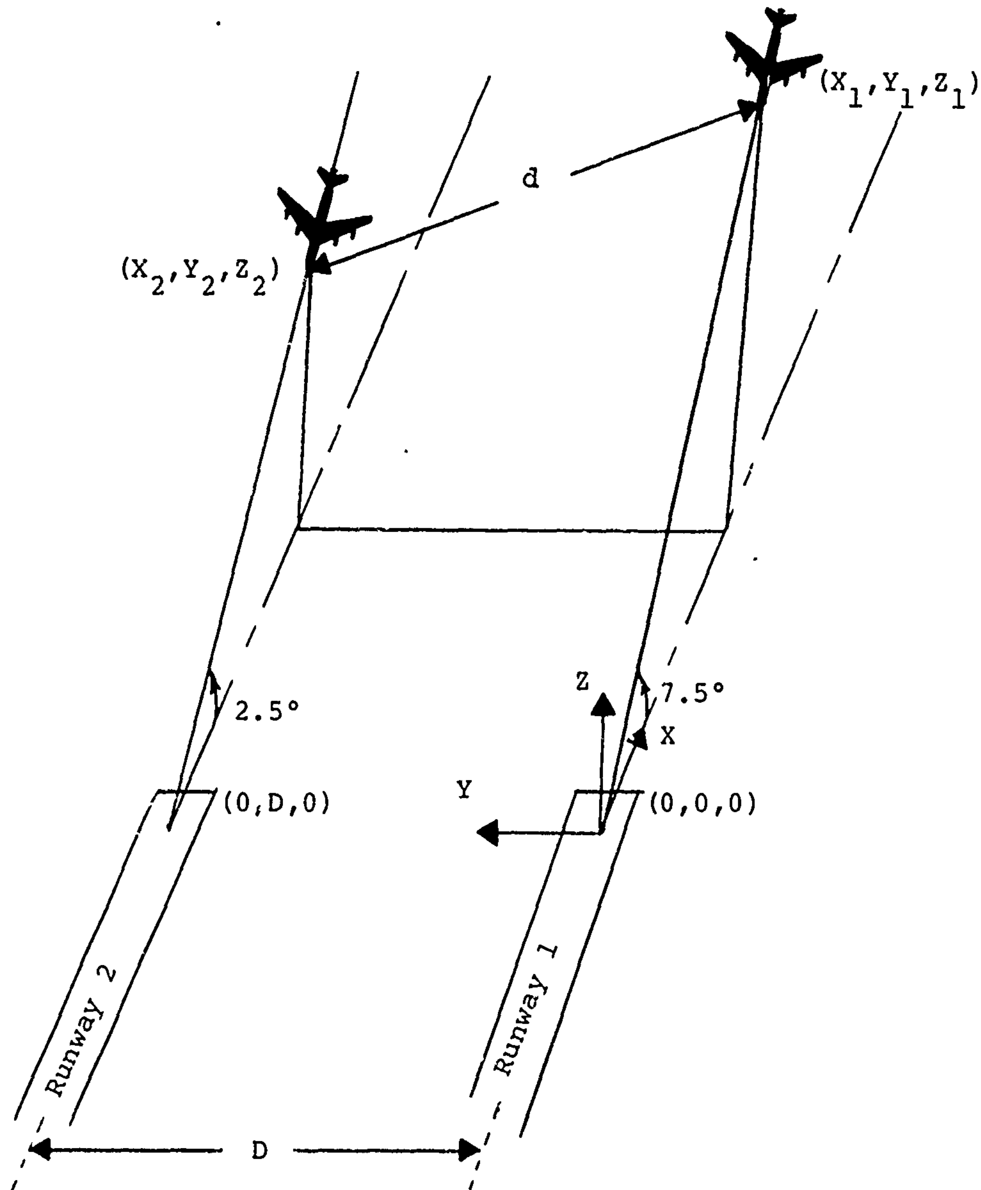


Figure 2.6.1-5

Probability of Collision Geometry fo
CTOL/STOL Independent Operations

The primary dimensions of interest for CTOL/STOL independent operations are lateral and vertical; therefore, lateral and vertical distributions are utilized in the determination of probability of collision.

Using the preceding assumptions, the probability of collision is analytically developed in Volume II.

2.6.2 PROBABILITY OF COLLISION DATA GENERATION

As stated in Section 2.6, the probability of collision between approaching aircraft is used in considering the reduction of the present lateral spacing criteria between parallel runways. This section describes all the combinations of aircraft and runway configurations, operations, and approach systems for which probability of collision data was generated in the Lateral Separation Study.

Specific combinations for CTOL/CTOL, CTOL/STOL, and STOL/STOL aircraft and runway configurations are described in detail in the following subsections along with a discussion of the probability of collision data generated for each combination. Results based on the combinations described in these sections are included in Appendix B in tabular form and are discussed in Section 3.2. An explanation of the tabular organization of results is also furnished in Section 3.2.

Figure 2.6.2-1 presents a classification of all cases considered in the probability of collision data generation for the CTOL/CTOL, CTOL/STOL, and STOL/STOL aircraft and runway configurations.

For the purpose of clarity, an explanation of acronyms and nomenclature shown in Figure 2.6.2-1 will now be given since these terms are used throughout the remainder of this discussion.

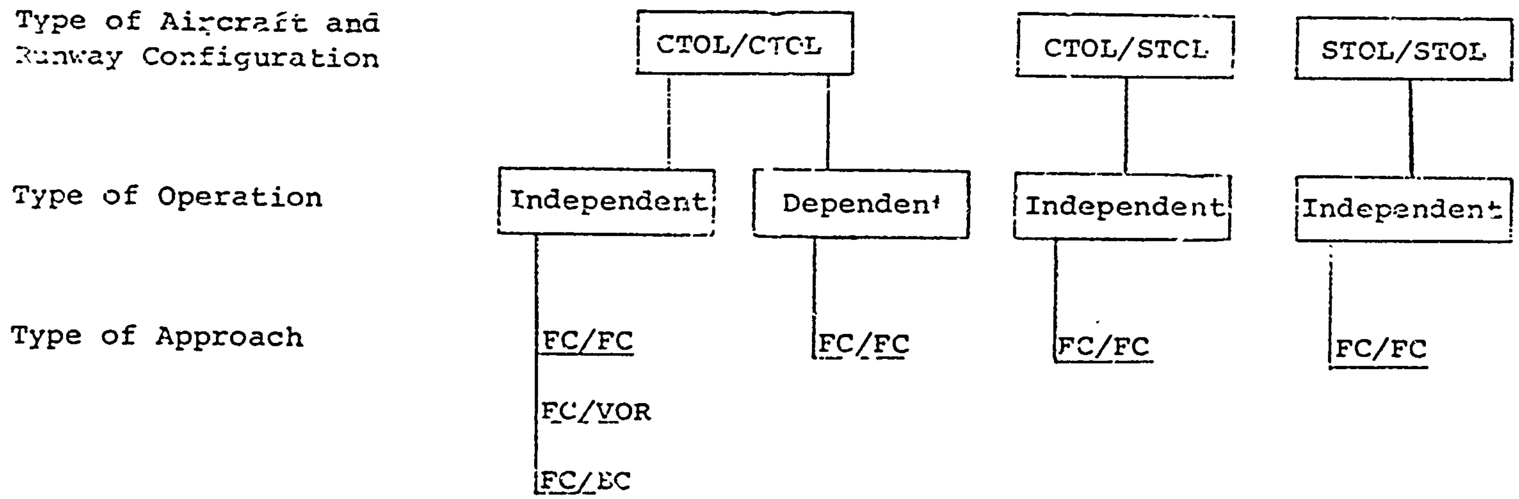
FC - Acronym referring to "front course" Category I ILS approach system.

BC - Acronym referring to "back course" Category I ILS approach system.

VOR - Acronym for an approach on a "VOR/DME" (VHF Omnidirectional Range/Distance Measuring Equipment) approach system. This approach is assumed to be conducted "to" the VOR station.

FC/FC - Symbol referring to two Category I aircraft approaching parallel runways via FC systems.

FC/BC - Refers to two Category I aircraft approaching parallel runways - one aircraft using a FC approach, and the other using a BC approach.



NOTE: The notation used above is X/Y
Y — Runway 1
X — Runway 2

Figure 2.6.2-1

Cases Considered in Probability of Collision Analysis

FC/VOR - Refers to two Category I aircraft approaching parallel runways - one aircraft using a FC approach and the other using the VOR approach.

The maximum range at which probabilities of collision for CTOL/CTOL independent and dependent operations are calculated is the turn-on range. The turn-on range was selected because it is assumed to represent the worst case condition. At ranges greater than this range, vertical separation between parallel approaches increases; therefore, the vertical coincidence assumption is no longer valid. At ranges less than this range, the lateral distribution standard deviation decreases, resulting in lower probabilities of collision. Based upon the measured distribution data from Volume II, Appendix H, the apparent turn-on range for the observed FC, BC, and VOR approaches was 6, 5, and 6 nmi, respectively.

Probabilities of collision were also evaluated at intermediate ranges of four and two miles. Probabilities were calculated at these ranges for various lateral spacing between runways. The lateral spacings considered were 5000, 4300, 3500, 3000, 2500, 2000, and 1500 feet. The 5000 feet lateral spacing case was selected since it is the current minimum spacing criteria between parallel runways for independent IFR operations. The lateral spacing of 4300 feet was selected as another case since this value represents the present lateral spacing between runways at several airports. The remainder of the lateral spacings considered were chosen so as to represent typical spacings between 3500 and 1500 feet.

Probabilities of collision for CTOL/STOL and STOL/STOL cases were considered at a maximum range from the STOL touchdown of 12,200 and 12,000 feet, respectively. The 12,200 foot range was chosen since this represents the maximum range from the touchdown for which measured STOL distribution data was available; thus, it represents the apparent turn-on range for the STOL aircraft. Probabilities of collision were calculated for the same lateral spacings as considered for the CTOL/CTOL case.

The parameter representing aircraft wing span, λ, was assumed to be 200 feet for all probability of collision calculations. This value represents the maximum wingspan of all aircraft user classes considered (Boeing 747) and is thus a worst case condition. All distribution data required for a probability of collision calculation for all cases at the previously described ranges is contained in Appendix H of Volume II. The

means of these distributions were assumed to define an "ideal" track, i.e., on an extension of the runway centerline, in the glideslope plane and traveling at the nominal approach speed.

2.6.2.1 CTOL/CTOL - Probability of Collision Data Generation

Specific combinations of approach systems for the CTOL/CTOL aircraft and runway configuration for which probability of collision data were generated include:

(a) FC/FC - Independent
(b) FC/VOR - Independent
(c) FC/BC - Independent
(d) FC/FC - Dependent

The probability of collision data generation for case (a) above was accomplished by

(1) evaluating the probability of collision at the initial range for a lateral spacing between the runways of 5000 feet.
(2) repeating step (1) with the lateral error distribution determined for the range of four miles and two miles;
(3) repeating the two preceding steps for lateral spacings of 1500, 2000, 2500, 3000, 3500, and 4300 feet.

These three steps are the same for evaluating probabilities of collision for cases (b) and (c), except that the PDF's for VOR-CTOL (Lateral), and BC-ILS-I-CTOL (Lateral) from Volume II, Appendix H are used for the respective cases. A detailed description of these PDF's is furnished in Volume II, Appendix H.

Figure 2.6.2-2 illustrates the conditions for which probabilities of collision were generated for FC/FC dependent operations (case (d)). As indicated in the figure, probability of collision data generation was divided into four main cases. The primary difference between the cases is that each case represents a different nominal longitudinal spacing between approaching aircraft.

As stated previously (Section 2.6), for dependent operations it is assumed that at some range greater than the outer marker, the controller has established the desired longitudinal spacing between the two aircraft and the nominal approach speeds for the two aircraft. This range is assumed to be 9 NMi (54720 feet), which corresponds to the approximate range at which the 1000 foot vertical separation is lost. It is further assumed that the nominal approach speeds for the two aircraft are equal (140 knots or 236.4 feet/second). The lateral PDF's used are those for the FC-ILS-I-CTOL (Lateral) system (Volume II, Appendix H) at the appropriate ranges.

	Case I	Case II	Case III	Case IV
Longitudinal spacing between adjacent aircraft, NMi	3	2	1	.25
Ranges* from threshold for which P_C was calculated, NMi	3 2 1	4 3 2 1	5 4 3 2 1	5 4 3 2 1

All cases calculated for lateral separations of 1500, 2000, 2500, 3000, 3500, 4300, and 5000 feet.

*NOTE: Range is measured from t... ...own point to the closest aircraft.

Figure 2...2-2

Cases Considered in Probability of Collision for CTOL/CTOL Dependent Operations

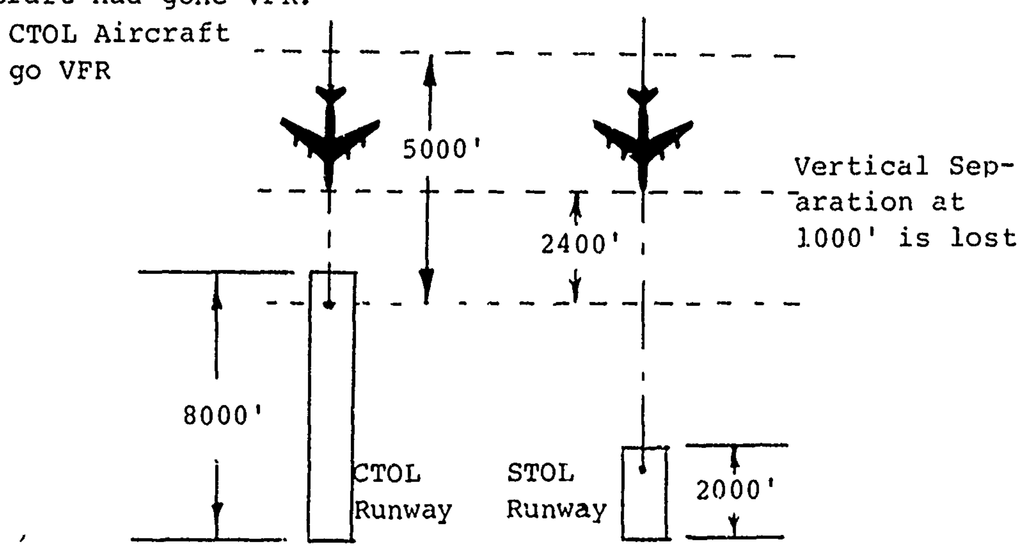
2.6.2.2 CTOL/STOL - Probability of Collision Data Generation

The range interval over which the probability of collision for a CTOL/STOL - FC/FC - independent operation is calculated is shown in Figure 2.6.2-3. The maximum range (12,200 feet) is determined as being the range at which the 1000 feet vertical separation is lost and the minimum range (5000 feet) corresponds to that range where CTOL aircraft "go visual", i.e., 200 feet altitude for Category I operating conditions.

Figure 2.6.2-4 illustrates the runway configurations and corresponding ranges from the touchdown at which probabilities of collision were calculated.

The distributions used for the STOL FC-ILS approach are those for the FC-ILS-I-STOL (Lateral and Vertical) systems defined in Volume II, Appendix H (both are gaussian), and the CTOL - FC-ILS distributions are those defined in Volume II, Appendix H for the FC-ILS-I-CTOL (Lateral and Vertical) systems at the evaluation ranges indicated in Figure 2.6.2-4.

The CTOL/STOL runway configuration indicated in the figure below was eliminated since the point at which vertical separation was one thousand feet occurred after the CTOL aircraft had gone VFR.



2.6.2.3 STOL/STOL - Probability of Collision Data Generation

Probability of collision data for STOL/STOL - FC/FC - independent approaches was generated at ranges from the touchdown of 12,000, 7,000, and 1,000 feet. The lateral error PDF's (gaussian) are given in Volume II, Appendix H for the FC-ILS-I-STOL (Lateral) system at the appropriate ranges.

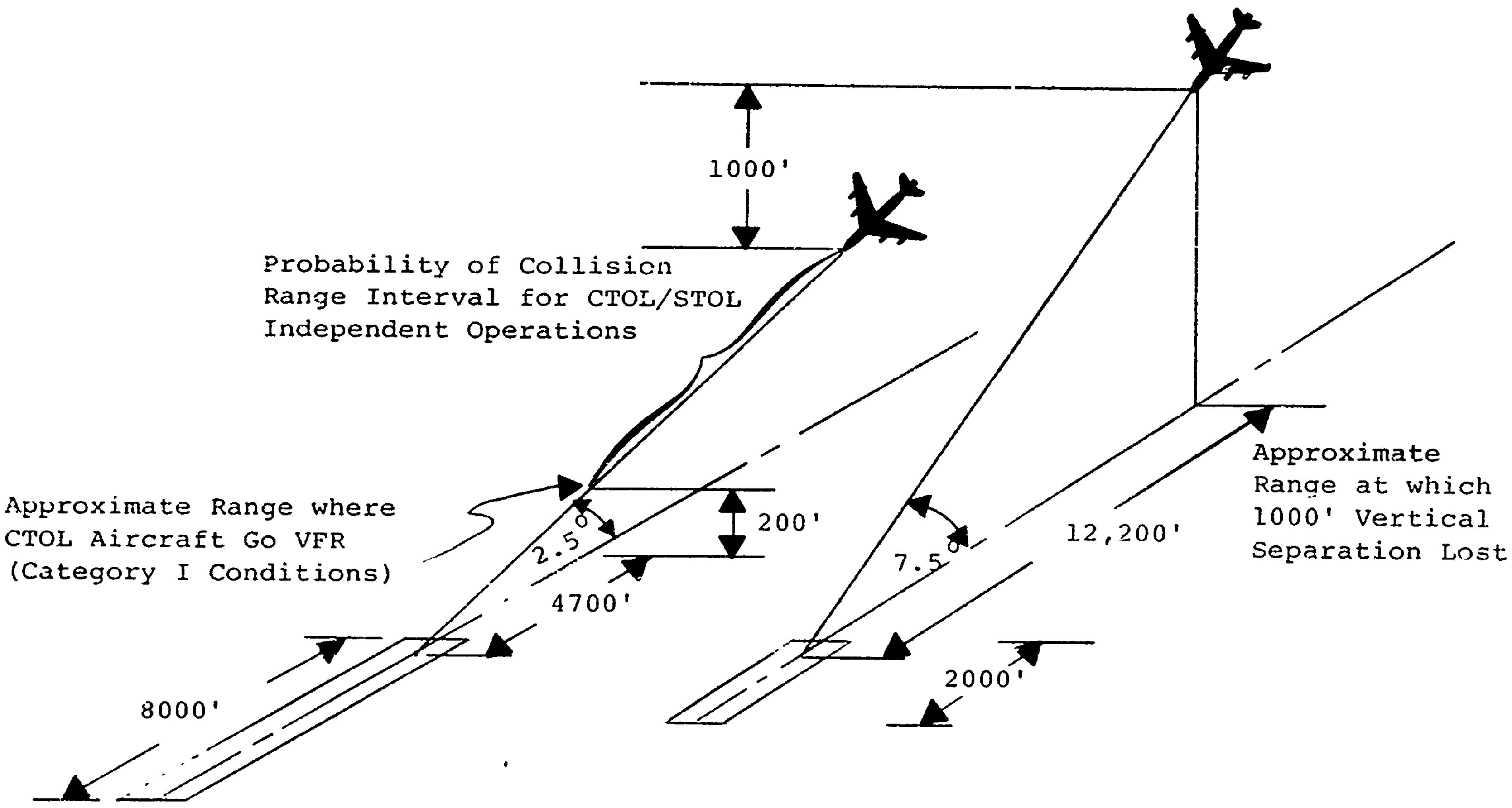


Figure 2.6.2-3 Probability of Collision Geometry for CTOL/STOL Independent Operations

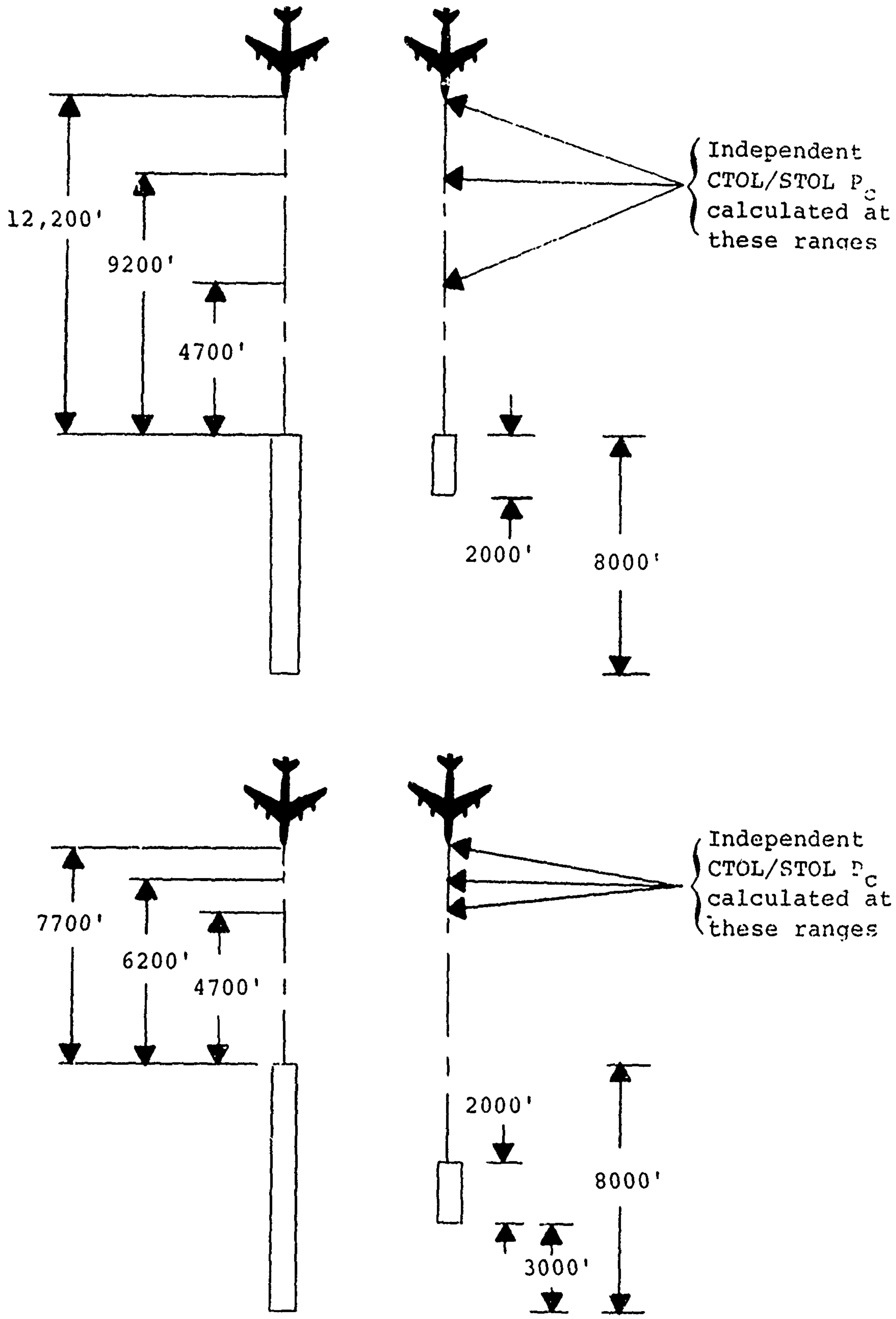


Figure 2.6.2-4 Runway Configurations Considered for CTOL/STOL Independent Operations

SECTION 2.7

BLUNDER ANALYSIS

A blunder analysis was performed to identify the airspace required for recovery from abnormal operations, blunders. This airspace is defined as the total lateral extension of the normal operating zone (NOZ) required to bring a blundered aircraft to a course parallel with either the runway centerline or parallel to the course of the aircraft in the adjacent approach path. This section contains a brief description of the blunder analysis. A detailed technical development of the blunder analysis is contained in Volume II of this report.

There are two basic types of blunder situations that are considered in the investigation of the runway separation requirements. Type 1 blunders occur when an aircraft that is on a track which intercepts the approach course at 10°, 20°, or 30° passes through the normal operating zone and proceeds toward the adjacent track. Type 1 blunders would typically occur during curved approach operations as the aircraft fails to turn from the base leg onto the final leg. Due to large intercept angles between the base leg and final leg, overshoots could easily occur. Type 2 blunders occur when an aircraft which is established on the final approach course (within the NOZ) makes a turn toward the adjacent course at 15°, 30°, or 45°. Type 2 blunders would typically be caused by a system malfunction - either equipment or pilot.

The remainder of this section is divided into subsections which discuss the analyses of recovery operations for single aircraft maneuvers and recovery operations for dual aircraft maneuvers. The parameters used in both analyses are contained in Table 2.7-1. In the following blunder discussions, the quantity being sought is the recovery airspace required, measured from the action point (assumed to occur at NOZ). The blunder analyses are not dependent upon the "cause" of the blunder; therefore, type 1 and type 2 blunders are analyzed identically.

The initial point at which the controller should identify a blunder is called the action point. For this investigation, it is assumed that the blunder is identified by a "position only" measurement technique; therefore, the action point is coincident with the NOZ boundary. If the measurement technique could sense heading and velocity, the

action point would occur sooner, i.e., some place within the NOZ, and the required blunder recovery airspace would be reduced.

Table 2.7-1 Blundered Aircraft Parameter Values

Parameters	Values	Units
Departure Angles		
Type 1 Blunder	10, 20, and 30	degrees
Type 2 Blunder	15, 30, and 45	degrees
DAS Range Accuracy (ϵ_R)	1.5, 1.0, .5, and .2	percentages of range
DAS Azimuth Accuracy (ϵ_A)	1.5, 1.0, and .5	degrees
DAS Update Delays	4, 2, 1, .5, .1, and .01	seconds
Aircraft Velocities	60, 80, 100, 120, 140, and 160	knots
Aircraft Bank Angles	10, 20, 30, and 40	degrees
Pilot/Aircraft Reaction Times	1.5, 5, and 8	seconds
Communication Times	1 to 10	seconds

2.7.1 SINGLE AIRCRAFT ANALYSIS

2.7.1.1 Introduction

The purpose of the single aircraft analysis is to evaluate the cross-track distance (blunder recovery airspace) required for an aircraft to recover from the type 1 and type 2 blunders. The blunder recovery maneuver is assumed to be a coordinated turn in the glideslope plane performed by the blundering aircraft. It is necessary to establish a set of ground rules and assumptions to serve as a guideline throughout the single aircraft analysis. These ground rules and assumptions are presented and explained below.

2.7.1.2 Approach

The blunder recovery airspace required for a single aircraft to recover from either of the two types of blunder

situations is evaluated by considering the geometry of the situation. In the type 2 blunder, the requirement for a corrective command from the controller is not known unt' the controller's presentation of the aircraft position reac. the defined normal operating zone limit. In normal operating circumstances, aircraft entering at large intercept angles are advised of their proximity to the extended runway centerline; however, depending on the pilot reaction and other factors, the type 1 blunder may not be alleviated. In the worst case, the controller does not detect the violation of the decision boundary until the aircraft has moved a cross-track distance equal to its cross-track velocity times the Data Acquisition System (DAS) update time and the DAS system error (EDAS). Figure 2.7.1-1 is a pictorial representation of this situation. The controller then transmits a correction maneuver command to the pilot. Because of the requirement for addresses in the command, the action information is not actually available to the pilot for a period of a few seconds. In this time and the time it takes for the pilot and aircraft to react, the aircraft continues along its deviated flight path. If at this point the aircraft starts a corrective maneuver, the aircraft is fully corrected, in terms of heading, within a distance proportional to the amount of heading change. The total of all these contributions constitutes the blunder recovery airspace.

The results of the single aircraft analysis are derived from the geometric representation shown in Figure 2.7.1-1 and are presented in Appendix C, with the exception of the EDAS. EDAS is dependent upon the location of the DAS, which is dependent on the specific airport configuration, and the location of the aircraft with respect to the DAS; therefore, it is evaluated separately.

The procedure for estimating EDAS for a specific configuration is discussed below. The EDAS considered is only that component which contributes to the lateral recovery airspace for a given blunder correction. Two DAS error sources are considered in this analysis - range error (ε_R) and azimuth error (ε_A). DAS lateral position errors are primarily affected by these errors.

In order to estimate the EDAS, it is necessary to know the location of both the DAS antenna as well as the blundered aircraft. These locations are specified as follows:

$X_{A/C}$ - Aircraft ground range to touchdown, ft.

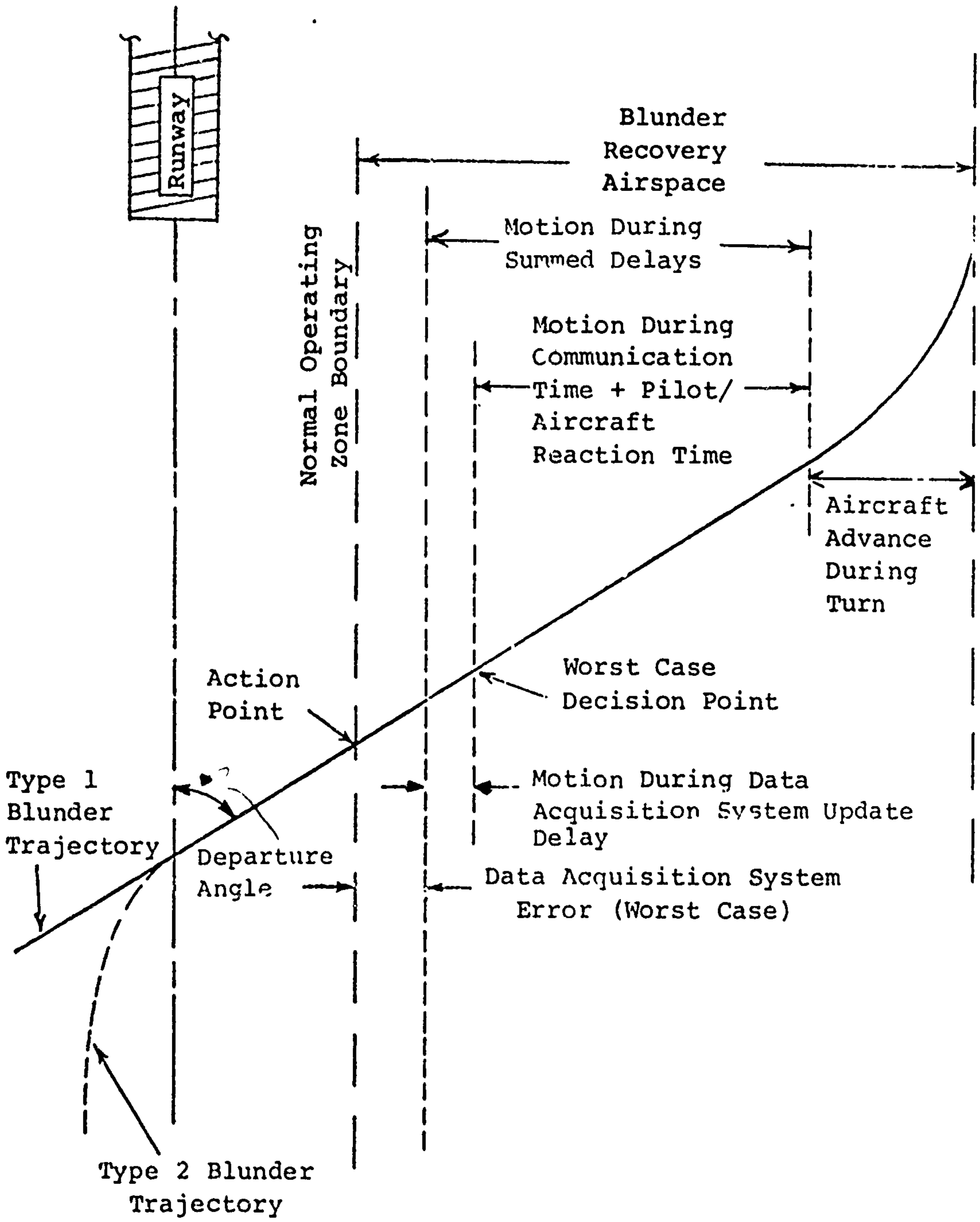


Figure 2.7.1-1

Single Aircraft Geometric Analysis of the Two Types of Blunders

$Y_{A/C}$ - Aircraft lateral location from the runway centerline, ft.

$Z_{A/C}$ - Aircraft altitude, ft.

X_{DAS} - DAS antenna ground range from touchdown, ft.

Y_{DAS} - DAS antenna lateral location from the runway centerline, ft.

Z_{DAS} - DAS antenna altitude, ft.

Figure 2.7.1-2 illustrates a possible DAS location configuration. Determination of the lateral component of EDAS due to range error and azimuth error is illustrated in Figure 2.7.1-2 and shown below.

$$EDAS = E_A \cos\rho + E_R \sin\rho \qquad (2.7.1\text{-}1)$$

where

$$E_A = R \tan \varepsilon_A \qquad (2.7.1\text{-}2)$$

$$E_R = \frac{\varepsilon_R \, R}{100} \qquad (2.7.1\text{-}3)$$

$$R = \sqrt{(X_{DAS} - X_{A/C})^2 + (Y_{DAS} - Y_{A/C})^2 + (Z_{DAS} - Z_{A/C})^2} \qquad (2.7.1\text{-}4)$$

$$\rho = \tan^{-1} \left| \frac{Y_{DAS} - Y_{A/C}}{X_{DAS} - X_{A/C}} \right| \qquad (2.7.1\text{-}5)$$

Possible values to consider for ε_A and ε_R are listed in Table 2.7-1. The resulting value of EDAS for a specific DAS location configuration should be added to the blunder recovery airspace data of Appendix C as discussed in the following section.

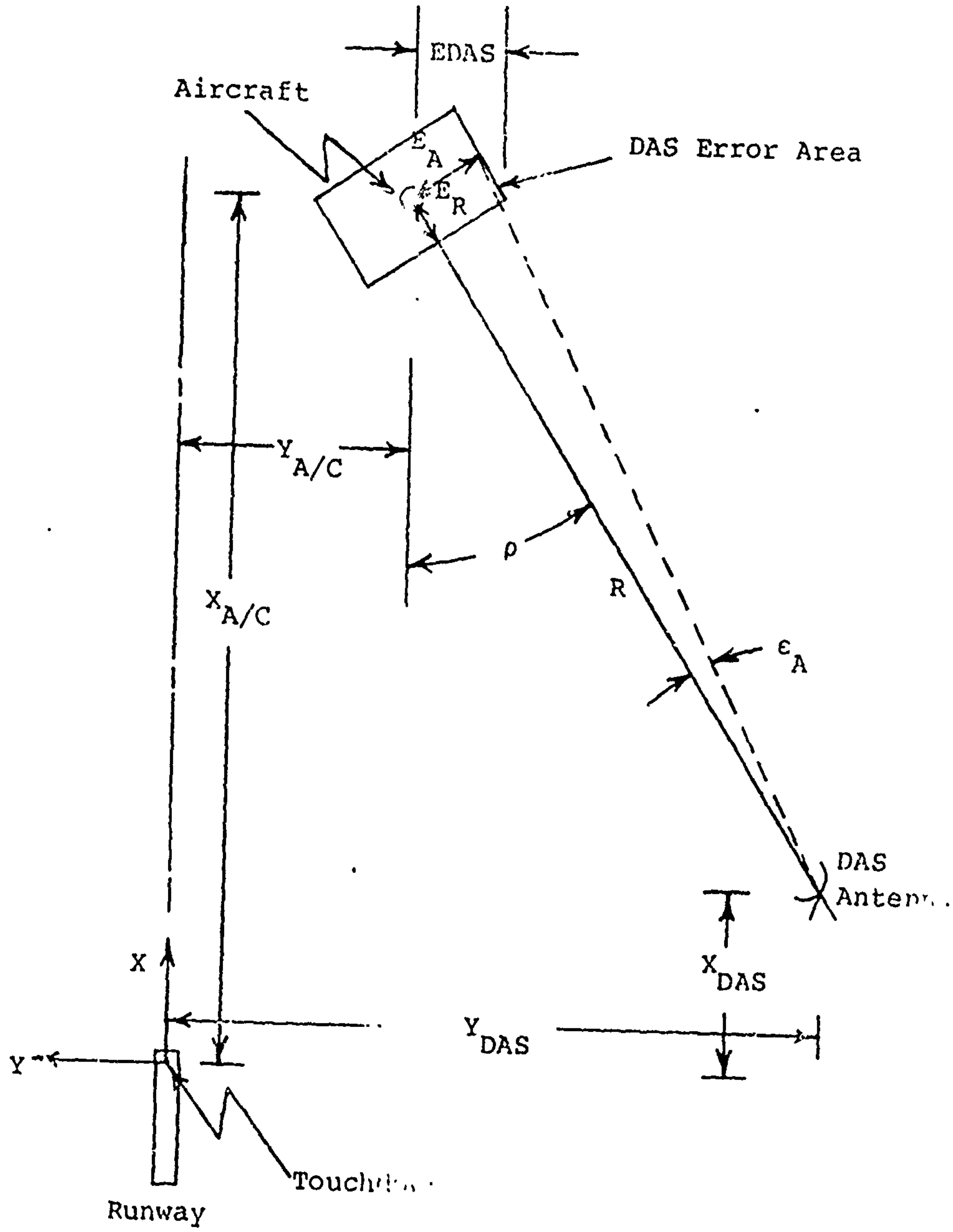


Figure 2.7.1-2 DAS Configuration

2.7.1.3 Results

The single aircraft analysis is used to determine the minimum airspace required for an aircraft to recover from either of the two types of blunder situations. The single aircraft analysis utilized combinations of the parameter values listed in Table 2.7·1. The lateral recovery airspace required for parameter combinations for the single aircraft blunder analysis is presented in tabular form in Appendix C. Values for EDAS should be added to these data when the position of the DAS antenna with respect to the blundered aircraft is known or can be approximated (Equations 2.7.1-1 through 5).

Typical output data from the single aircraft analysis is contained in Table 2.7.1-1. This table is a selected sample of the data in Appendix C, and the column headings are explained as follows:

Departure Angle (deg.) - the angle at which a blundered aircraft heads toward the adjacent approach course measured from the extended runway centerline.

Velocity (knots) - the velocity of the blundered aircraft.

Bank Angle (deg.) - the bank angle that the blundered aircraft uses to make the corrective maneuver.

Summed Delays (sec.) - a total of all the delays of the blundered aircraft, including DAS Update Delay, Communication Time, and Pilot/Aircraft Reaction Time.

Blunder Recovery Airspace (ft.) - the lateral recovery airspace, excluding EDAS, required for a blundered aircraft to recover from the type 1 or type 2 blunders, measured from the action point and perpendicular to the extended runway centerline.

Table 2.7.1-2 illustrates a reference blunder case and shows the changes of the blunder recovery airspace with respect to the variations of each parameter. The reference blunder case is shown in Figure 2.7.1-3 to illustrate the meaning of each parameter. Table 2.7.1-2 also shows the best case blunder conditions, least required runway airspace, and the worst case blunder conditions for the parameter set considered. A blunder sensitivity analysis was performed about the reference blunder case to identify the critical parameters. The dominant contributor to the blunder recovery airspace is the system delays followed by departure angle, aircraft

Table 2.7.1-1 Single Aircraft Blunder Data

DEPARTURE ANGLE(DEG.)	VELOCITY (KNOTS)	BANK ANGLE(DEG.)	SUMMED DELAYS(SEC.)	BLUNDER RECOVERY AIRSPACE(FT.)
30.00	100.00	40.00	2.50	352.23
30.00	100.00	40.00	9.00	900.77
30.00	100.00	40.00	16.00	1491.50
30.00	100.00	40.00	22.00	1997.84
30.00	100.00	30.00	2.50	416.27
30.00	100.00	30.00	9.00	964.60
30.00	100.00	30.00	16.00	1555.54
30.00	100.00	30.00	22.00	2061.88
30.00	100.00	20.00	2.50	536.62
30.00	100.00	20.00	9.00	1085.16
30.00	100.00	20.00	16.00	1675.69
30.00	100.00	20.00	22.00	2182.23
30.00	100.00	10.00	2.50	883.17
30.00	100.00	10.00	9.00	1431.70
30.00	100.00	10.00	16.00	2022.43
30.00	100.00	10.00	22.00	2528.78
30.00	120.00	40.00	2.50	456.58
30.00	120.00	40.00	9.00	1114.82
30.00	120.00	40.00	16.00	1823.70
30.00	120.00	40.00	22.00	2431.31
30.00	120.00	30.00	2.50	548.79
30.00	120.00	30.00	9.00	1207.04
30.00	120.00	30.00	16.00	1915.91
30.00	120.00	30.00	22.00	2523.52
[illegible]	[illegible]	[illegible]	2.50	722.19
[illegible]	[illegible]	[illegible]	9.00	1380.34
[illegible]	[illegible]	[illegible]	16.00	2089.22
[illegible]	[illegible]	[illegible]	22.00	2696.83
[illegible]	[illegible]	10.00	[illegible]	1221.13
[illegible]	[illegible]	10.00	[illegible]	1879.37
[illegible]	[illegible]	10.00	[illegible]	2588.25
[illegible]	[illegible]	10.00	[illegible]	3195.86

Table 2.7.1-2 Single Aircraft Data Trends
(Excluding DAS Error)

	Departure Angle (deg.)	Velocity (knots)	Bank Angle (deg.)	Summed Delays (sec.)	Blunder Recovery Airspace (ft.)
Reference Case	20	100	30	9	611.95
Summed Delays Variation	20	100	30	16	1016.03
	20	100	30	22	1362.39
Bank Angle Variation	20	100	20	9	666.12
	20	100	10	9	822.12
Velocity Variation	20	120	30	9	756.51
	20	140	30	9	908.48
Departure Angle Variation	30	100	30	9	964.80
	45	100	30	9	1522.92
Best Case	10	60	40	2.5	49.73
Worst Case	45	160	10	22	7962.98

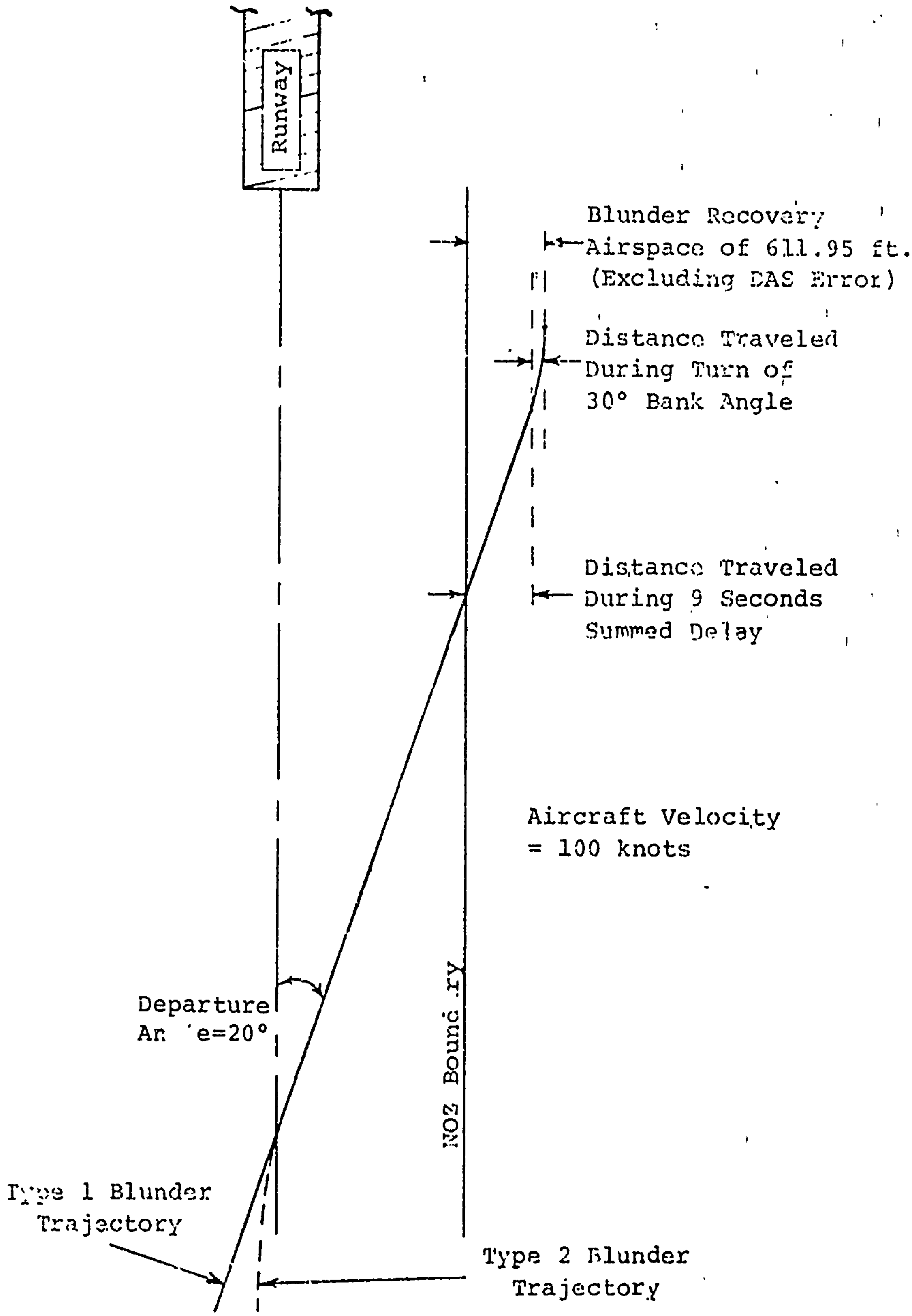


Figure 2.7.1-3 Reference Blunder Case for Single Aircraft

bank angle in order of decreasing dominance.

2.7.2 DUAL AIRCRAFT ANALYSIS

2.7.2.1 Introduction

The purpose of the dual aircraft analysis is to evaluate the blunder recovery airspace required for a blundered aircraft to recover from the type 1 and type 2 blunders assuming that the blundered aircraft does not respond to controller warnings. The failure to respond makes it necessary for the controller to command an avoidance maneuver for the adjacent aircraft approaching the adjacent runway. The recovery of the blundered aircraft is considered complete when the heading of the blundered aircraft is the same as the heading of the aircraft on the adjacent approach course, meaning that both aircraft are flying parallel courses at that instant. Therefore, this analysis technique not only requires maneuvering the blundered aircraft but also requires maneuvering the aircraft on the adjacent course. The same set of ground rules, assumptions, and parameters used for the single aircraft analysis are used, along with other assumptions, to serve as a guideline throughout the dual aircraft analysis.

2.7.2.2 Approach

The geometry of the situation is again used in the evaluation of the required blunder recovery airspace. Figure 2.7.2-1 is a pictorial representation of the dual aircraft maneuver situation. In both types of blunders, the requirement for a corrective command from the controller is not known until the controller's presentation of the blundered aircraft position reaches the defined NOZ limit. However, the controller does not detect the violation of the decision boundary until the blundered aircraft has moved a cross-track distance equal to its cross-track velocity times the DAS update delay and the DAS system error. The controller then transmits a correction maneuver to the pilot of the blundered aircraft. After allowing time for the blundered aircraft to respond to the corrective maneuver issued, the controller alerts the controller of the aircraft on the adjacent approach course. The blundered aircraft now has traveled an additional cross-track distance due to the delays of the controller's communication time. While the blundered aircraft is traveling an even farther cross-track distance due to the delays of the pilot and the aircraft, the controller of the adjacent aircraft is responding to the situation and transmitting a message to his

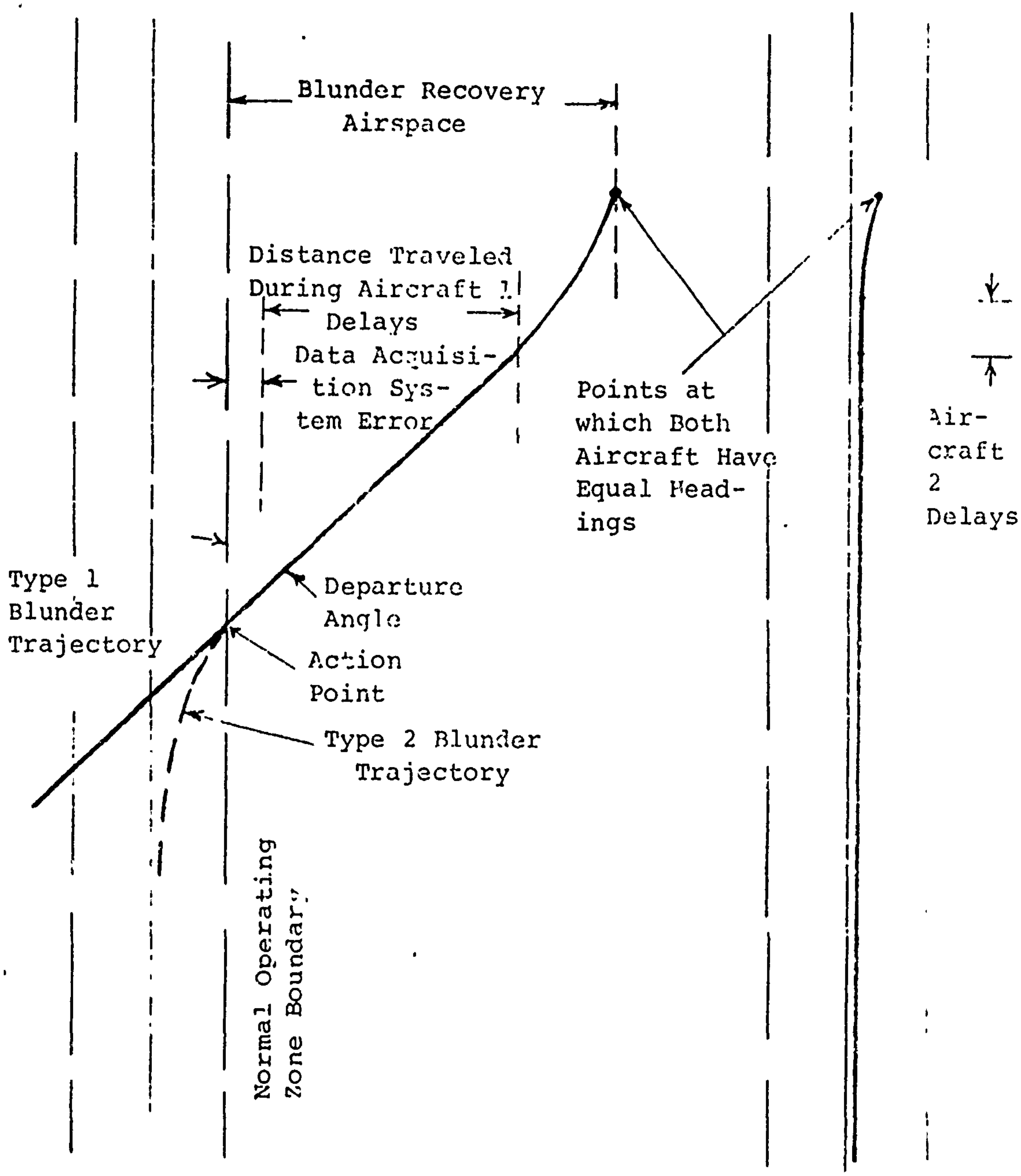


Figure 2.7.2-1 Dual Aircraft Geometric Analysis

aircraft to maneuver. At this point in time, the blundered aircraft has started its correction maneuver, and the adjacent aircraft starts its maneuver after the pilot and aircraft delays. When the heading of the adjacent aircraft becomes equal to that of the blundered aircraft, the blunder condition is considered to be corrected. Knowing these conditions and delays, it is possible to determine the cross-track distance traveled by the blundered aircraft before the blunder condition was corrected.

The procedure described above is best defined as a sequence of delays which directly affects the cross-track distance traveled by a blundered aircraft. This sequence is illustrated in Table 2.7.2-1 and is used to evaluate the cross-track distance of the blundered aircraft. It should be noted that the DAS error is evaluated separately, as explained in Section 2.7.1.2.

Table 2.7.2-1

Dual Aircraft Blunder Analysis
Sequence of Delays

Blundered Aircraft	Adjacent Aircraft
(1) DAS update delay	
(2) $Controller_1$ communication time	
(3) $Pilot_1$ reaction time	
(4) $Aircraft_1$ response time	(4) $Controller_1$ to $Controller_2$ delay
(5) $Aircraft_1$ turn time	(5) $Controller_2$ communication time
	(6) $Pilot_2$ reaction time
	(7) $Aircraft_2$ response time
	(8) $Aircraft_2$ turn time

The blundered aircraft parameters considered in this analysis are listed in Table 2.7-1, and the adjacent aircraft parameters and their values are

Adjacent Aircraft Summed Delays = 1, 4, 7, 10 seconds
Adjacent Aircraft Turn Rate = 3 deg./sec.

2.7.2.3 Results

The dual aircraft analysis is used to determine the blunder recovery airspace required for a blundered aircraft to recover from the two types of blunder conditions. By maneuvering both the blundered aircraft and the aircraft on the adjacent approach course, the blunder condition is considered resolved when the headings of both aircraft are equal. The dual aircraft analysis was used to determine the lateral recovery airspace for all combinations of the parameter values (excluding EDAS), and the results are presented in tabular form in Appendix D. Values for EDAS should be added to the data of Appendix D when the position of the DAS antenna is known for a particular system, as described in Section 2.7.1.2 (Equations 2.7.1-1 through 2.7.1-5).

Appendix D contains the lateral recovery airspace required for all parameter combinations for the dual aircraft analysis. Table 2.7.2-2 contains typical output data from the dual aircraft analysis and represents an overview of the data contained in Appendix D. The column headings for Table 2.7.2-2 are explained as follows:

Blundered Departure Angle (deg.) - the angle at which a blundered aircraft heads toward the adjacent approach course measured from the extended runway centerline.

Blundered Velocity (knots) - the velocity of the blundered aircraft.

Blundered Bank Angle (deg.) - the bank angle that the blundered aircraft uses to make the corrective maneuver.

Blundered Summed Delays (sec.) - a total of all the delays of the blundered aircraft, including DAS Update Delay, Communication Time, and Pilot/Aircraft Reaction Time.

Adjacent Summed Delays (sec.) - a total of all the delays of the adjacent aircraft, including the Communication Time and

Table 2.7.2-2 Dual Aircraft Blunder Data

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SYSTEM DELAYS (SEC.)	ADJACENT SYSTEM DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
30.00	160.00	40.00	2.50	1.00	174.87	5.21	[illegible]
30.00	160.00	40.00	2.50	4.00	180.00	5.77	352.23
30.00	160.00	40.00	2.50	7.00	180.00	5.77	352.23
30.00	160.00	40.00	2.50	10.00	180.00	5.77	352.23
30.00	160.00	40.00	9.00	1.00	174.87	11.71	896.54
30.00	160.00	40.00	9.00	4.00	180.00	12.27	900.77
30.00	160.00	40.00	9.00	7.00	180.00	12.27	900.77
30.00	160.00	40.00	9.00	10.00	180.00	12.27	900.77
30.00	160.00	40.00	16.00	1.00	174.87	18.71	1487.27
30.00	160.00	40.00	16.00	4.00	180.00	19.27	1491.50
30.00	160.00	40.00	16.00	7.00	180.00	19.27	1491.50
30.00	160.00	40.00	16.00	10.00	180.00	19.27	1491.50
30.00	160.00	40.00	22.00	1.00	174.37	24.71	[illegible]
30.00	160.00	40.00	22.00	4.00	180.00	25.27	1997.84
30.00	160.00	40.00	22.00	7.00	180.00	25.27	1997.84
30.00	160.00	40.00	22.00	10.00	180.00	25.27	1997.84
30.00	160.00	30.00	2.50	1.00	172.37	6.04	[illegible]
30.00	160.00	30.00	2.50	4.00	175.47	7.01	415.72
30.00	160.00	30.00	2.50	7.00	180.00	7.25	416.27
30.00	160.00	30.00	2.50	10.00	180.00	7.25	416.27
30.00	160.00	30.00	9.00	1.00	172.37	12.54	951.23
30.00	160.00	30.00	9.00	4.00	175.47	13.51	964.26
30.00	160.00	30.00	9.00	7.00	180.00	13.75	[illegible]
30.00	[illegible]	30.00	9.00	10.00	[illegible]	13.75	[illegible]
30.00	[illegible]	30.00	16.00	1.00	172.37	19.54	1541.96
30.00	[illegible]	30.00	16.00	4.00	175.47	20.51	1554.09
30.00	[illegible]	30.00	16.00	7.00	180.00	20.75	1555.54
[illegible]	[illegible]	30.00	16.00	10.00	180.00	20.75	1555.54
30.00	[illegible]	30.00	22.00	1.00	172.37	25.54	2046.30
30.00	[illegible]	30.00	22.00	4.00	175.47	26.51	2061.33
30.00	[illegible]	30.00	22.00	7.00	180.00	26.75	[illegible]
30.00	[illegible]	30.00	22.00	10.00	180.00	26.75	[illegible]

Pilot/Aircraft Reaction Time measured from the time $controller_1$ communicates to $controller_2$. This occurs at the end of the Blundered Summed Delays.

<u>Corrected Parallel Headings</u> (deg.) - the heading angle of both the blundered and adjacent aircraft at the point in time when they are flying parallel courses (i.e., the blunder is corrected). For this analysis, the approach heading was assumed to be 180^{o}.

<u>Blunder Correction Time</u> (sec.) - the total time required for a blundered aircraft to attain a flight course parallel with that of the aircraft on the adjacent course (total blunder recovery time measured from the time the blundered aircraft reaches the action point until the blunder is corrected).

<u>Blunder Recovery Airspace</u> (ft.) - the lateral recovery airspace, excluding EDAS, required for a blundered aircraft to recover to a course parallel with that of the adjacent aircraft. The blunder recovery airspace is measured from the action point perpendicular to the extended runway centerline.

Some examples of the output data are shown in Table 2.7.2-3. This table illustrates a reference blunder case and shows the changes of the blunder recovery airspace with respect to the variations of each parameter. An illustration of the reference case is shown in Figure 2.7.2-2. Also, the best case blunder conditions and the worst case blunder conditions for the dual aircraft analysis for the given parameter set are shown in Table 2.7.2-3. It should be noted that the blunder recovery airspace does not always vary with a change of the adjacent summed delays. This condition is due to the blundered aircraft correcting its heading error before the adjacent aircraft has time to start a maneuver.

Table 2.7.2-3 Dual Aircraft Data Trends
(Excluding DAS Error)

	Blundered Departure Angle (deg.)	Blundered Velocity (knots)	Blundered Bank Angle (deg.)	Blundered Summed Delays (sec.)	Adjacent Summed Delays (sec.)	Blunder Recovery Airspace (ft.)
Reference Case	20	100	30	9	1	607.41
(Adjacent) Summed Delays Variation	20	100	30	9	4	611.95
	20	100	30	9	7	611.95
(Blundered) Summed Delays Variation	20	100	30	16	1	1011.49
	20	100	30	22	1	1357.85
(Blundered) Bank Angle Variation	20	100	20	9	1	648.58
	20	100	10	9	1	729.88
(Blundered) Velocity Variation	20	120	30	9	1	746.89
	20	140	30	9	1	890.96
(Blundered) Departure Angle Variation	30	100	30	9	1	951.23
	45	100	30	9	1	1486.80
Best Case	10	60	40	2.5	1	49.73
Worst Case	45	160	10	22	10	6896.57

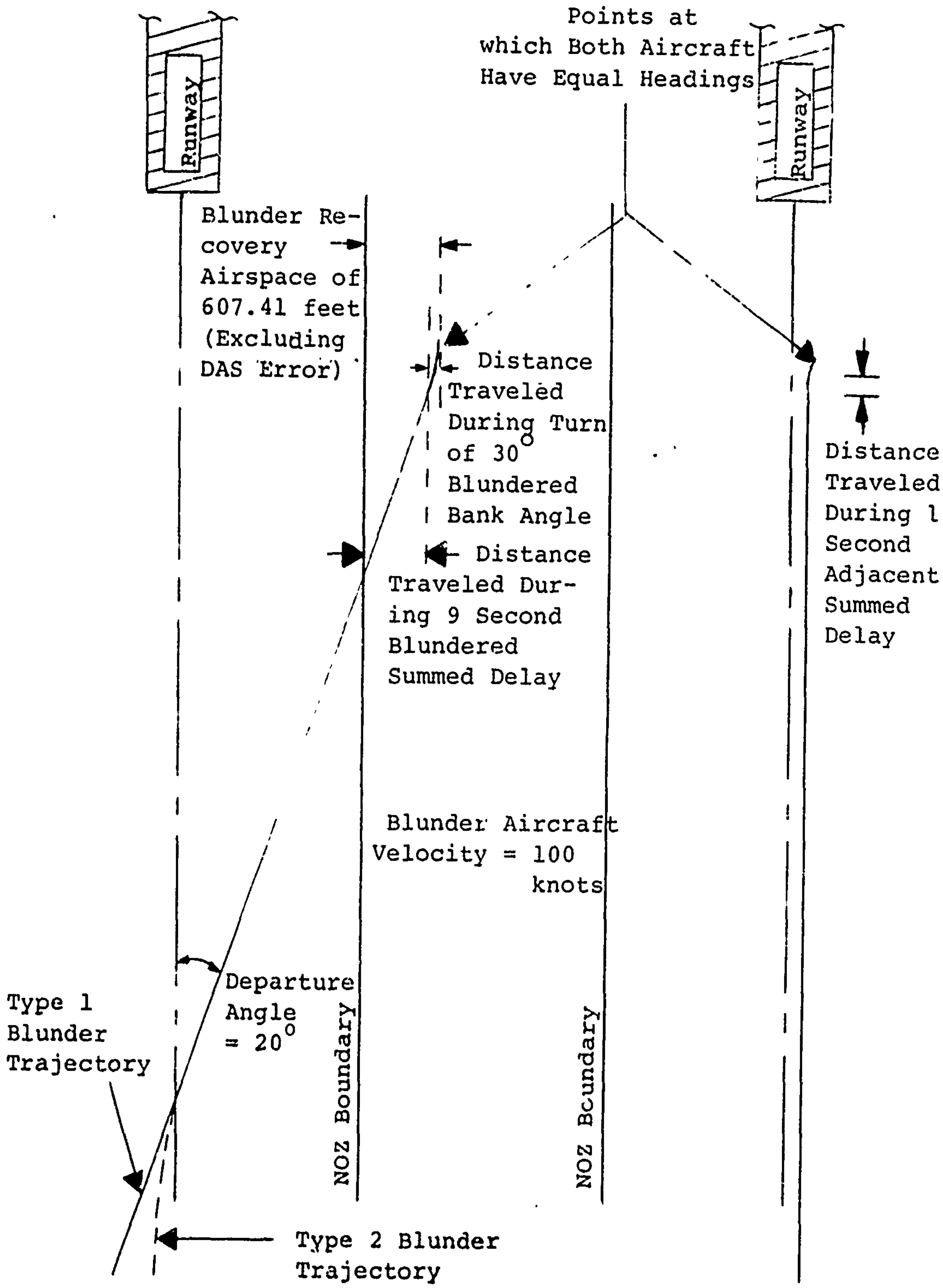


Figure 2.7.2-2 Dual Aircraft Reference Blunder Case

SECTION 3

STUDY OUTPUTS

The results of this study necessary to determine the minimum runway spacing and the relative safety of various runway configurations are presented in this section. The methods and techniques used to determine the contents of this section have been discussed, from a general standpoint, in Section 2 and in detail in Volume II of this report. The three sets of data included in this section are NOZ (Section 3.1), probability of collision (Section 3.2) and blunder recovery airspace (Section 3.3).

The NOZ's are determined, using the techniques previously discussed, for the following systems:

FC-ILS-I-CTOL,
FC-ILS-II-CTOL,
BC-ILS-1-CTOL,
VOR-CTOL, and
FC-ILS-I-STOL.

The NOZ's for these systems are discussed in Section 3.1 and the data presented in Appendix A.

The probability of collision data is determined for:

CTOL/CTOL independent,
CTOL/CTOL dependent,
STOL/STOL independent, and
CTOL/STOL independent.

The probability of collision data is discussed in Section 3.2, and the data is presented in Appendix B.

The airspace required to recover from blunders occurring under a number of specified conditions is presented in Section 3.3 and Appendices C and D.

SECTION 3.1

NORMAL OPERATING ZONE DATA

An important parameter utilized in the determination of minimum runway spacings is the normal operating zone (NOZ). The NOZ is defined as being that zone which includes either 68 percent or 95 percent of the operations. Since the mean of the lateral error probability density function is assumed to be zero, the NOZ is symmetric about the extended runway centerline. Selection of the 68 percent zone or the 95 percent zone is usually dependent on the traffic rate and controller communications workload.

The NOZ data is discussed in two parts. The first part (Section 3.1.1) is concerned with the NOZ for approach systems in general. The second part (Section 3.1.2) is concerned with the NOZ for CTOL/STOL skewed operations. The NOZ data for both sections is presented in Appendix A.

3.1.1 NOZ DATA FOR APPROACH SYSTEMS

The 68 percent and 95 percent NOZ's are determined from a direct integration of the lateral error PDF's for each of the five lateral approach systems listed below:

FC-ILS-I-CTOL
FC-ILS-II-CTOL
BC-ILS-I-CTOL
VOR-CTOL
FC-ILS-I-STOL

The NOZ is divided into three regions: approach, runway, and departure. The approach region begins at the turn-on range and ends at either 5000 feet or 1500 feet from touchdown for CTOL and STOL aircraft, respectively. This range corresponds to the minimum range at which the aircraft should be VFR. The second region is the region over the runway itself which consists of two parallel lines spaced according to the value of the NOZ at the VFR range. The departure region is a mirror image of the approach region. The three regions are pictured in Figure 3.1.1-1. The locus of NOZ points are plotted in Appendix A for each of the five approach systems.

3.1.2 NOZ DATA FOR CTOL/STOL SKEWED RUNWAYS

Due to the lack of measured distribution data for STOL aircraft on curved departures, the method of NOZ determination for this case is different from the previous case. The 68

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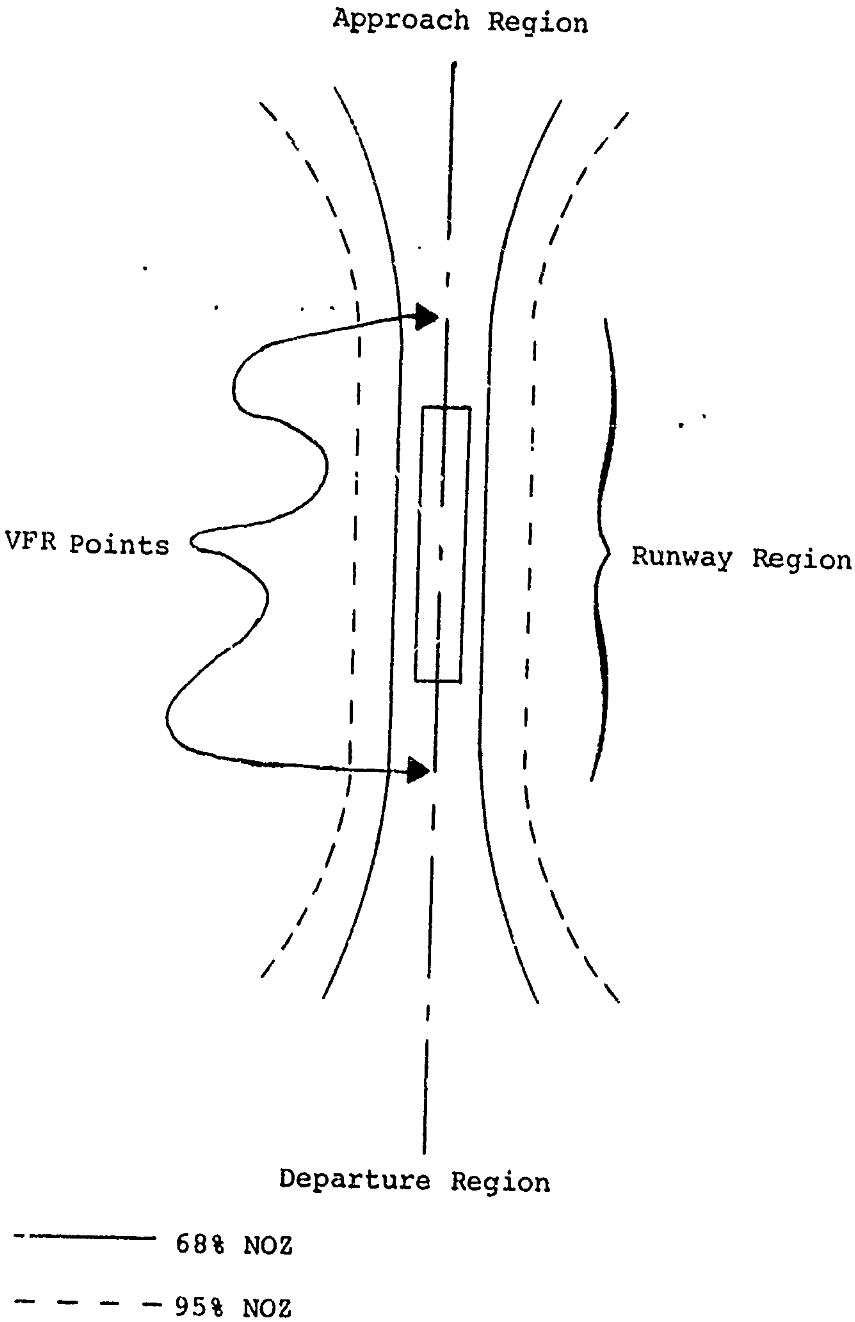

Figure 3.1.1-1 NOZ Regions

percent and 95 percent NOZ's for the STOL system in the CTOL/STOL configuration were determined using the techniques described in Volume II (Section 2.5.3.2). The NOZ for runway spacing is required only at the point of minimum spacing between the CTOL runway and the STOL departure path. The 68 percent and 95 percent NOZ's for skew angles from ten to ninety degrees in ten degree increments at the CTOL runway - STOL departure path minimum spacing point are tabulated in Appendix A.

SECTION 3.2

PROBABILITY OF COLLISION DATA

Probability of collision results obtained in the Lateral Separation Study are discussed in this section and presented in tabular form in Appendix B. These results represent a primary output of the Lateral Separation Study and constitute a portion of the information necessary to determine a minimum allowable spacing between parallel runways for aircraft operating under IFR conditions. All cases categorized under CTOL/CTOL, CTOL/STOL, and STOL/STOL for which probability of collision data was generated are shown in Figure 3.2-1.

The objective of this analysis is to provide a relative measure of safety for minimum runway spacing considerations; the objective is not to provide an absolute measure of probability of collision. For this reason, worst case conditions are employed in all probability of collision calculations. Definition of the worst case condition for each specific system considered is dependent upon which dimensions are the primary dimensions of interest. In each case the primary dimensions of interest are the only dimensions in which statistics are used; in the other dimensions, the absolute worst condition is assumed as illustrated in Table 3.2-1. For the above reasons, the probability of collision data discussed in this section should be utilized as a "relative" measure of safety as opposed to an "absolute" measure.

Probability of collision data for CTOL/CTOL independent, CTOL/CTOL dependent, CTOL/STOL, and STOL/STOL are not directly comparable, e.g., data obtained for CTOL/CTOL independent operations should not be compared with data obtained for CTOL/STOL independent operations. The reason the different cases cited cannot be compared in terms of the probability of collision data generated for each case is that some cases employ statistics in only one dimension; whereas, other cases employ statistics in two dimensions. Specific dimensions in which statistics were utilized for each case is shown in Table 3.2-1. The type of distribution used for a specific dimension in each case is also shown. Cases in Table 3.2-1 which employ statistics in two dimensions produce probability of collision data smaller in magnitude than data generated for one dimensional cases.

CTOL/CTOL probability of collision data are contained in Appendix B, Tables B-2 through B-7. Probability of collision data for CTOL/STOL and STOL/STOL approaches are

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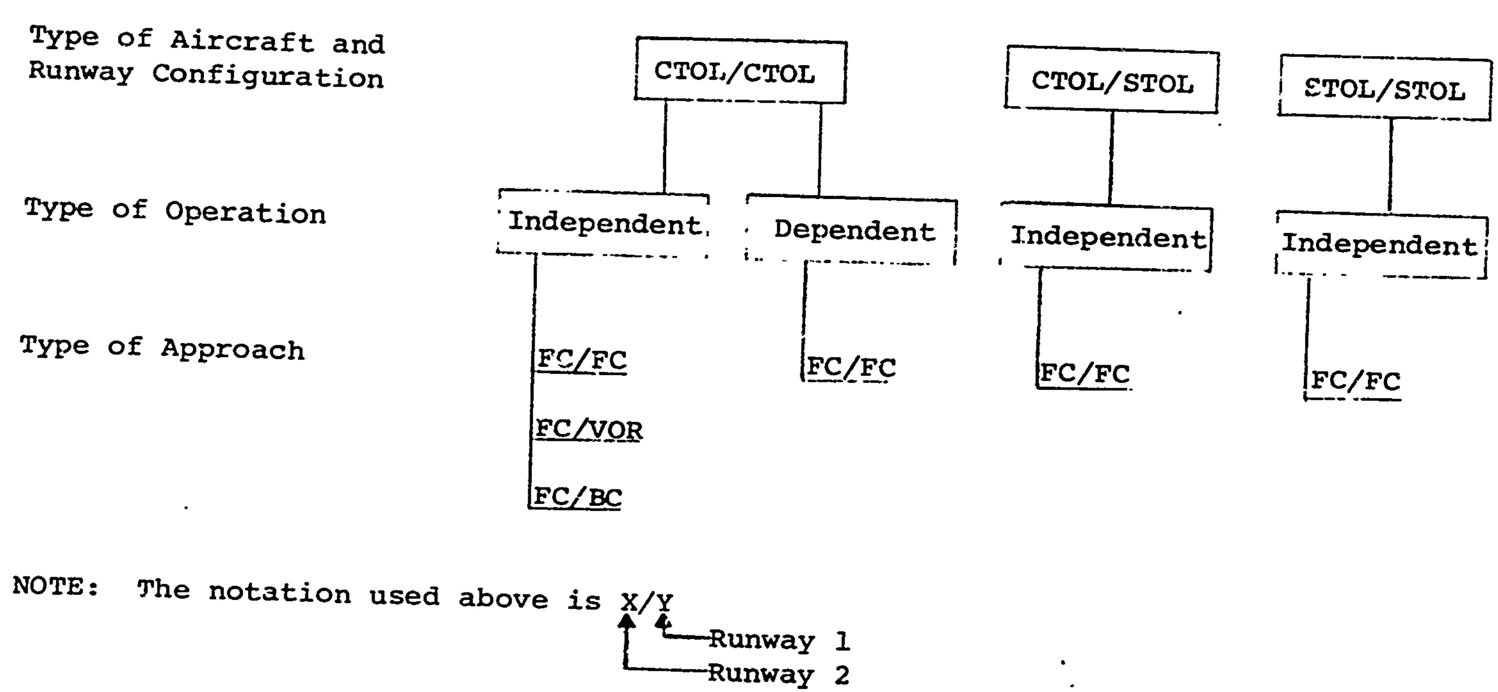


Figure 3.2-1

Cases Considered in Probability of Collision Analysis

Table 3.2-1

Distributions for Lateral, Vertical, and Longitudinal Dimensions for the Approach Systems

Type of Aircraft Runway Configuration and Operation	Primary Dimensions of Interest	Type of Distribution Assumed*	Worst Case Condition
CTOL/CTOL Independent	Lateral	FP Output/FP Output	Longitudinal and Vertical Coincidence
CTOL/CTOL Dependent	Lateral Longitudinal	FP Output/FP Output Gaussian/Gaussian	Vertical Coincidence
CTOL/STOL Independent	Lateral Vertical	FP Output/Gaussian Gaussian/Gaussian	Longitudinal Coincidence
STOL/STOL Independent	Lateral	Gaussian/Gaussian	Longitudinal and Vertical Coincidence

*FP - Fokker-Planck

contained in Tables B-9 and 10 and Table B-11, respectively. A table guide to all cases which are categorized under CTOL/CTOL, CTOL/STOL, and STOL/STOL approaches is also furnished in Appendix B. A discussion of the data along with examples illustrating how to use the tables and interpret the data is given in the following sections.

3.2.1 CTOL/CTOL PROBABILITY OF COLLISION DATA

Probability of collision data for the CTOL/CTOL aircraft and runway configuration was generated for both independent and dependent operations where independent and dependent operations are defined as in Section 2.6. For the purpose of clarity, discussions of the data generated for these two types of operations are presented separately.

CTOL/CTOL Independent Operations

Tables B-2 through B-4 in Appendix B contain probability of collision data for all CTOL/CTOL independent operations considered. The type of approach, type of operation, and the type of aircraft and runway configuration are specified in the captions of the respective tables.

As indicated in Figure 3.2.1-1, probabilities of collision contained in each of these three tables are calculated at the turn-on range and at four and two miles from the runway threshold for a fixed lateral spacing between runways. The data were generated at the above ranges for lateral spacings of 1500, 2000, 2500, 3000, 3500, 4300, and 5000 feet between runways. Data contained in Tables B-2, B-3, and B-4 are for FC/FC, FC/VOR, and FC/BC approach systems, respectively.

CTOL/CTOL Dependent Operations

Probability of collision data generated for CTOL/CTOL dependent operations is contained in Tables B-5 through B-8 of Appendix B. The only approach system considered for dependent operations was FC/FC. Each of the tables corresponds to a different longitudinal spacing between approaching aircraft; i.e., Tables B-5, B-6, B-7, and B-8 were generated assuming longitudinal spacings of three, two, one, and one-fourth miles, respectively. Figure 3.2.1-2 illustrates the ranges of the leading aircraft from the runway threshold for which probability of collision was calculated for each of the longitudinal spacings above. For a given longitudinal spacing and the above range values, the probability of collision was calculated for lateral spacings of 1500, 2000, 2500, 3000, 3500, 4300, and 5000 feet.

Aircraft and Runway Configuration

Table B-1

CTOL/CTOL* Probability of Collision Data for FC/FC** Independent Operations***

Lateral Separation, Feet	Range from Threshold, N. Miles	Probability of Collision
1500	6 4 2	
2000	6 4 2	
3000	6 4	

*Specifies Type of Aircraft and Runway Configuration

**Specifies Type of Approach

***Specifies Type of Operation

Figure 3.2.1-1

Explanation of Heading Information for Probability of Collision Tables

	Case I	Case II	Case III	Case IV
Longitudinal spacing between adjacent aircraft, NMi	3	2	1	.25
Ranges* from threshold for which P_C was calculated, NMi	3 2 1	4 3 2 1	5 4 3 2 1	5 4 3 2 1

All cases calculated for lateral separations of 1500, 2000, 2500, 3000, 3500, 4300, and 5000 feet.

*NOTE: Range is measured from touchdown point to the closest aircraft.

Figure 3.2.1-2

Cases Considered in Probability of Collision for CTOL/CTOL Dependent Operations

3.2.2 CTOL/STOL INDEPENDENT OPERATIONS

Tables B-9 and B-10 contain probability of collision data generated for CTOL/STOL approaches. The primary difference between data in the two tables is that data in Table B-9 is based on the runway configuration depicted in Figure 3.2.2-1a, and data contained in Table B-10 is based on runway configuration in Figure 3.2.2-1b.

As indicated in Table B-9, probability of collision data was calculated at ranges from the threshold of 12,200, 9,200, and 4,700 feet for a fixed lateral spacing. Probability collision data in Table B-10 was calculated at ranges from the CTOL touchdown point of 7,700, 6,200, and 4,700 feet for a fixed lateral spacing. Probability of collision data in each of these tables was generated at each of the specified ranges for lateral separations of 1500, 2000, 2500, 3000, 3500, 4300, and 5000 feet.

3.2.3 STOL/STOL INDEPENDENT OPERATIONS

Table B-11 in Appendix B contains probability of collision data generated for STOL/STOL - FC/FC - independent operations. Data was generated at ranges of 12,000, 7,000 and 1,000 feet from the touchdown point for lateral spacings between runways of 1500, 2000, 2500, 3000, 3500, 4300, and 5000 feet.

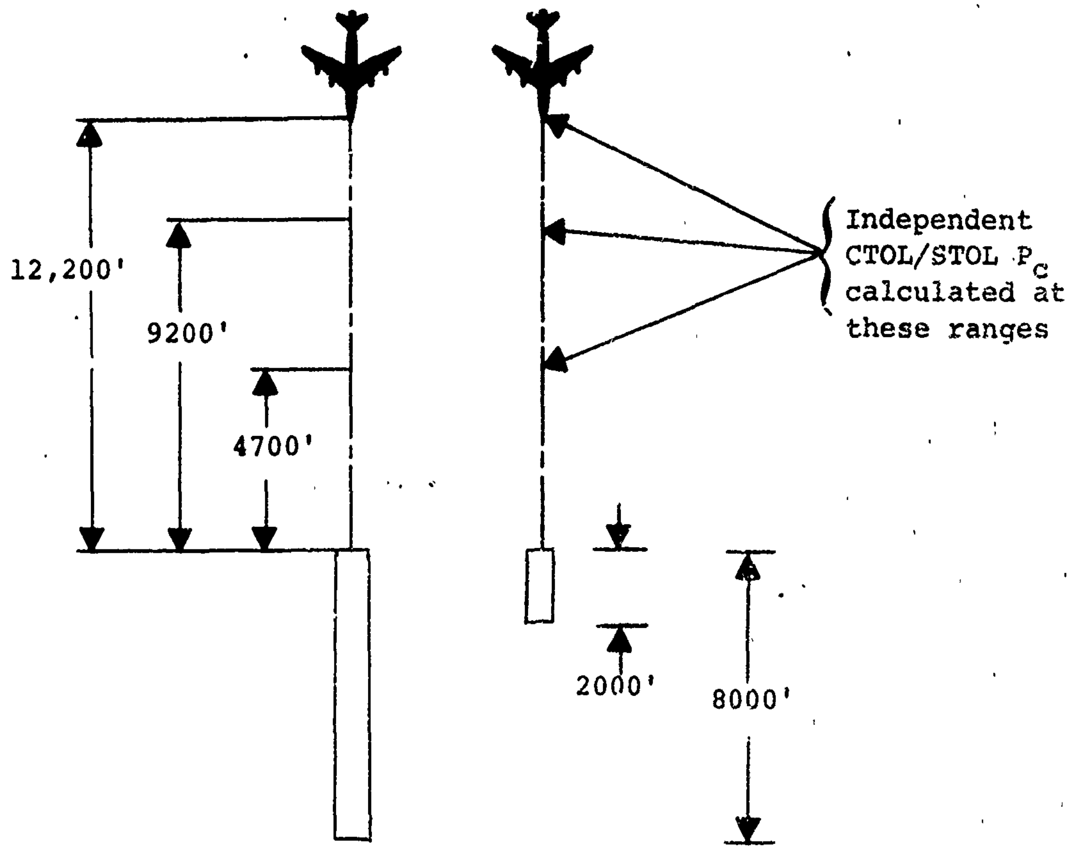


Figure 3.2.2-1a Runway Configuration for CTOL/STOL Independent Operations with No Threshold Displacement

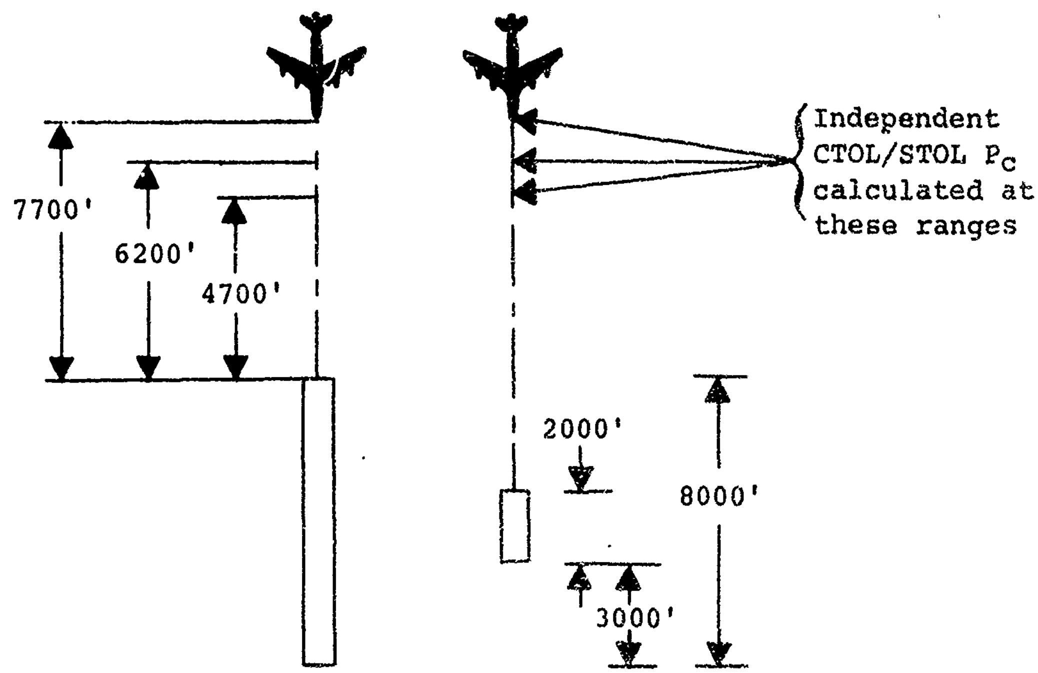


Figure 3.2.2-1b Runway Configuration for CTOL/STOL Independent Operations with 3000' Threshold Displacement

SECTION 3.3

BLUNDER DATA

The blunder analysis is an investigation of the airspace required for an aircraft to recover from abnormal operations or blunders. This airspace is identified as the total lateral extension of the normal operating zone (NOZ) required to bring a blundered aircraft to a course parallel with either the runway centerline or parallel to the course of the aircraft in the adjacent parallel approach path. A thorough description of the blunder analysis is presented in Section 2.7.

There are two basic types of blunder situations that were considered in the evaluation of the runway separation requirements. Type 1 blunders occur when an aircraft that is on a track which intercepts the approach course at 10°, 20°, and 30°, passes through the normal operating zone, and proceeds toward the adjacent track. Type 2 blunders occur when an aircraft which is established on the final approach course within the NOZ makes a turn toward the adjacent course at 15°, 30°, and 45°.

The blunder analysis was divided into two areas which analyze recovery operations for single aircraft recovery maneuvers and recovery operations for dual aircraft maneuvers. Since the blunder analyses are not dependent upon the "cause" of the blunder, type 1 and type 2 blunders are analyzed identically.

The blunder recovery airspace required for a single aircraft recovery maneuver for either of the two types of blunder situations was evaluated by considering the geometry of the situation as shown in Figure 3.3-1.

The parameters used in the single aircraft analysis are those specified in Table 3.3-1. The blunder recovery area, for all possible combinations of these parameter values, can be obtained from the results of the analysis. The blunder data, excluding the DAS error, for the single aircraft analysis is presented in tabular form in Appendix C. Typical output data from the single aircraft analysis is contained in Table 3.3-2, where the column headings are explained as follows:

<u>Departure Angle</u> (deg.) - the angle at which a blundered aircraft heads toward the adjacent approach course measured from the extended runway centerline.

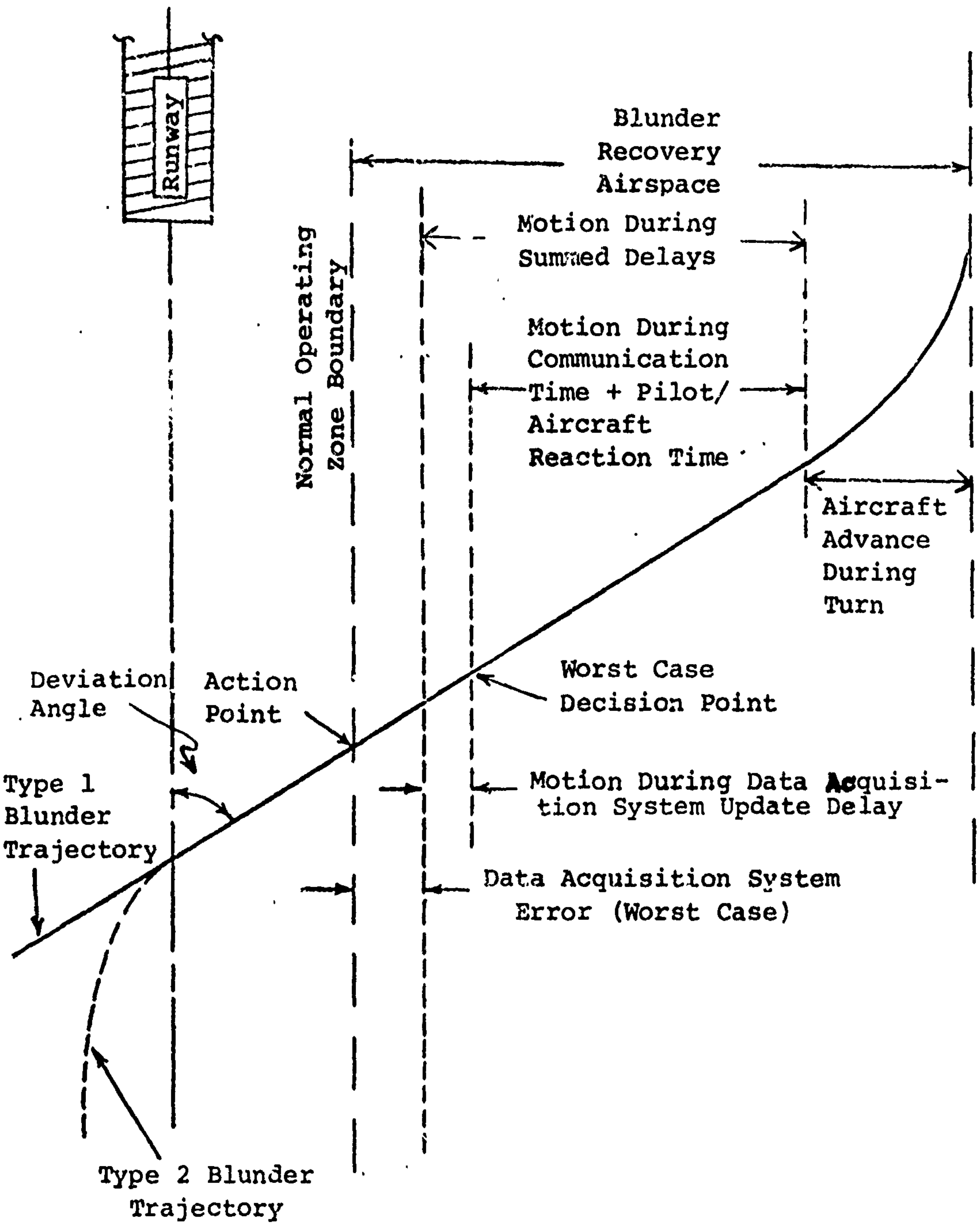


Figure 3.3-1

Single Aircraft Geometric Analysis of the Two Types of Blunders

Table 3.3-1 Blundered Aircraft Parameter Values

Parameters	Values	Units
Departure Angles		
Type 1	10, 20, and 30	degrees
Type 2	15, 30, and 45	degrees
DAS Range Accuracy (ε_R)	1.5, 1.0, .5, and .2	percentages of range
DAS Azimuth Accuracy (ε_A)	1.5, 1.0, and .5	degrees
DAS Update Delays	4, 2, 1. .5, .1, and .01	seconds
Aircraft Velocities	60, 80, 100, 120, 140, and 160	knots
Aircraft Bank Angles	10, 20, 30, and 40	degrees
Pilot/Aircraft Reaction Times	1.5, 5, and 8	seconds
Communication Times	1 to 10	seconds

Table 3.3-2 Single Aircraft Blunder Data

DEPARTURE ANGLE (DEG.)	VELOCITY (KNOTS)	BANK ANGLE (DEG.)	SUMMED DELAYS (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
30.00	100.00	40.00	2.50	352.23
30.00	100.00	40.00	9.00	900.77
30.00	100.00	40.00	16.00	1491.50
30.00	100.00	40.00	22.00	1997.84
30.00	100.00	30.00	2.50	416.27
30.00	100.00	30.00	9.00	964.80
30.00	100.00	30.00	16.00	1555.54
30.00	100.00	30.00	22.00	2061.88
30.00	100.00	20.00	2.50	536.62
[illegible]	100.00	20.00	9.00	1085.16
[illegible]	100.00	20.00	16.00	1675.89
[illegible]	100.00	20.00	22.00	2182.23
30.00	100.00	10.00	2.50	883.17
30.00	100.00	10.00	9.00	1431.70
30.00	100.00	10.00	16.00	2022.43
30.00	100.00	10.00	22.00	2528.78
30.00	120.00	40.00	2.50	456.58
30.00	120.00	40.00	9.00	1114.82
30.00	120.00	40.00	16.00	1823.70
30.00	120.00	40.00	22.00	2431.31
30.00	120.00	30.00	2.50	548.79
30.00	120.00	30.00	9.00	1207.04
[illegible]	120.00	30.00	16.00	1915.91
[illegible]	120.00	30.00	22.00	2523.52
30.00	[illegible]	20.00	[illegible]	722.10
30.00	[illegible]	20.00	[illegible]	1380.34
30.00	[illegible]	20.00	16.00	2089.22
30.00	[illegible]	20.00	22.00	2696.83
30.00	[illegible]	[illegible]	[illegible]	1221.13
30.00	[illegible]	[illegible]	[illegible]	1879.37
30.00	[illegible]	[illegible]	16.00	2588.25
30.00	[illegible]	[illegible]	22.00	3195.86

Velocity (knots) - the velocity of the blundered aircraft.

Bank Angle (deg.) - the bank angle that the blundered aircraft uses to make the corrective maneuver.

Summed Delays (sec.) - a total of all the delays of the blundered aircraft, including DAS Update Delay, Communication Time, and Pilot/Aircraft Reaction Time.

Blunder Recovery Airspace (ft.) - the lateral recovery airspace excluding EDAS, required for a blundered aircraft to recover from the type 1 and type 2 blunders, measured from the action point and perpendicular to the extended runway centerline.

To utilize the single aircraft analysis data contained in Appendix C, the desired set of parameter values to be studied must first be selected from Table 3.3-1. For the purpose of illustration, assume values for the parameters as follows:

Departure Angle	- 30 degrees
DAS Range Accuracy (ε_R)	- .5 percent of range
DAS Azimuth Accuracy (ε_A)	- 1.0 degrees
Das Update Delay	- 1 second
Aircraft Velocity	- 100 knots
Aircraft Bank Angle	- 30 degrees
Pilot/Aircraft Reaction Time	- 5 seconds
Communication Time	- 4 seconds

First, find the departure angle (30 degrees) in the blunder data table (Table 3.3-2). The aircraft velocity (100 knots) and the aircraft bank angle (30 degrees) can now be found in the appropriate columns. Sum the DAS update delay (1 second), the pilot/aircraft reaction time (5 seconds), and the communication time (4 seconds) to yield the summed delay (10 seconds). The desired Blunder Recovery Airspace (1,049.15 feet), excluding DAS error, can be found by linear interpolation between the two recovery airspaces, (964.80 feet and 1,555.54 feet) for the appropriate two closest summed delay values (9 seconds and 16 seconds).

It should be noted that the Blunder Recovery Airspace of Appendix C does not include the Data Acquisition System error (EDAS). The value of EDAS may be calculated using the desired values of ε_R (.5 percent of range) and ε_A (1 degree) and the procedure discussed below.

In order to determine the EDAS, it is necessary to know the location of the DAS antenna as well as the blundered aircraft. These locations are specified as follows:

$X_{A/C}$ - Aircraft ground range to touchdown, ft.

$Y_{A/C}$ - Aircraft lateral location from the runway centerline, ft.

$Z_{A/C}$ - Aircraft altitude, ft.

X_{DAS} - DAS antenna ground range from touchdown, ft.

Y_{DAS} - DAS antenna lateral location from the runway centerline, ft.

Z_{DAS} - DAS antenna altitude, ft.

Figure 3.3-2 illustrates a possible DAS location configuration. Determination of the lateral component of the EDAS due to range error and azimuth error is illustrated in Figure 3.3-2 and shown below.

$$EDAS = E_A \cos\rho + E_R \sin\rho$$

where

$$E_A = R \tan \varepsilon_A$$

$$E_R = \frac{\varepsilon_R R}{100}$$

$$R = \sqrt{(X_{DAS} - X_{A/C})^2 + (Y_{DAS} - Y_{A/C})^2 + (Z_{DAS} - Z_{A/C})^2}$$

$$\rho = \tan^{-1} \left| \frac{Y_{DAS} - Y_{A/C}}{X_{DAS} - X_{A/C}} \right|$$

Assuming values of the EDAS location parameters as follows:

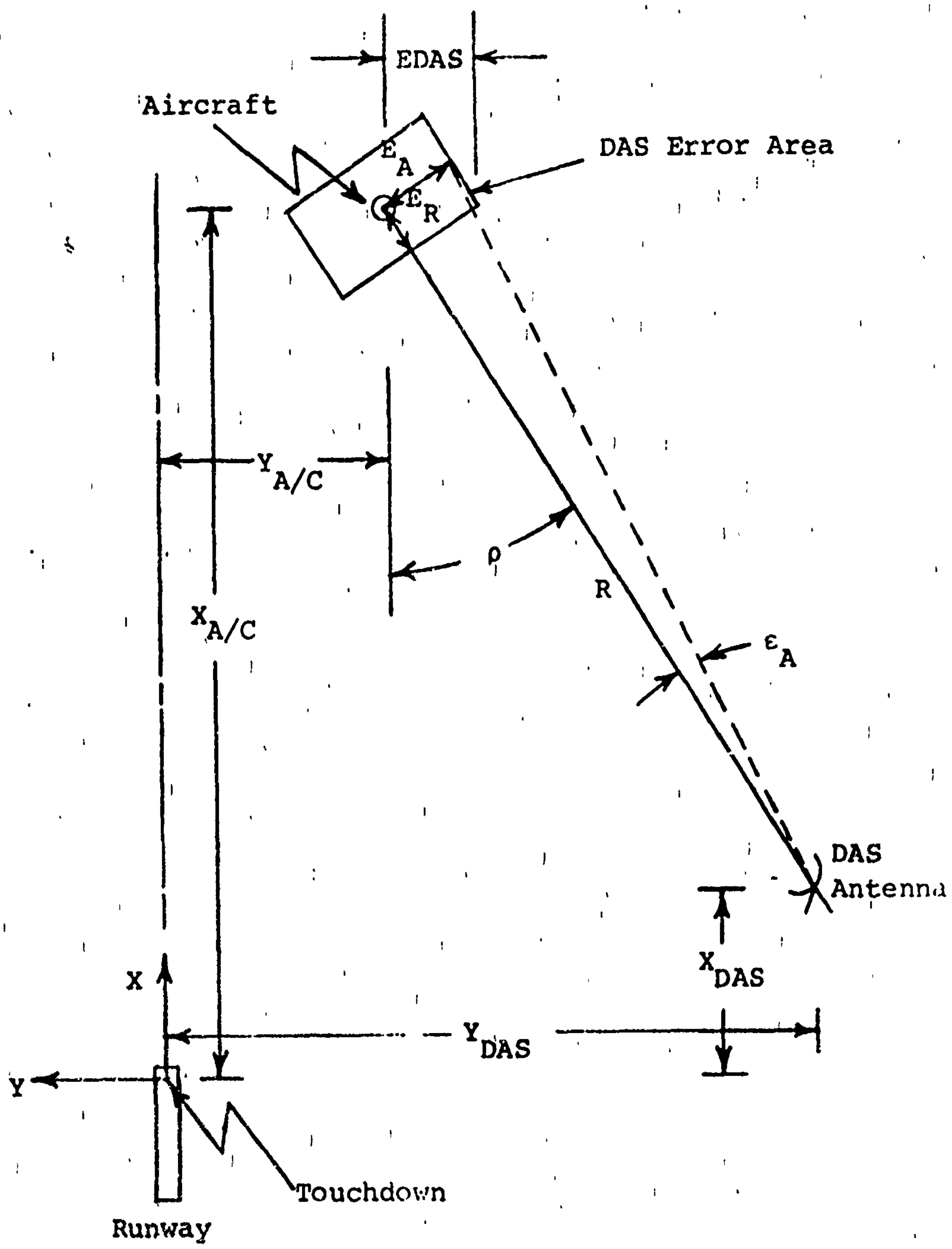


Figure 3.3-2 DAS Configuration

$X_{A/C}$ = 6,000 ft.

$Y_{A/C}$ = -1,500 ft.

$Z_{A/C}$ = 300 ft.

X_{DAS} = 500 ft.

Y_{DAS} = -2,500 ft.

Z_{DAS} = 0 ft.

EDAS is calculated to be 101.17 feet. The value of EDAS (101.17 feet) is added to the blunder recovery airspace (1,049.15 feet) to find the total airspace required (1,150.32 feet) for an aircraft to recover from the defined blunder condition.

The dual aircraft analysis was used to evaluate the blunder recovery airspace required for a blundered aircraft to recover from the type 1 and type 2 blunders, assuming that the blundered aircraft failed to respond to the controller's warnings. The failure to respond makes it necessary for the controller to command an avoidance maneuver for the adjacent aircraft approaching the adjacent runway. The recovery of the blundered aircraft was considered complete when the heading of the blundered aircraft was the same as the heading of the aircraft on the adjacent approach course, meaning that both aircraft were flying parallel courses at that instant.

The geometry of the situation, as shown in Figure 3.3-3, was used to evaluate the required blunder recovery airspace for a blundered aircraft to recover to a course parallel with that of the adjacent aircraft. The parameter combinations used in the dual aircraft analysis for the blundered aircraft are those specified in Table 3.3-1. The parameter values used for the adjacent aircraft are 1, 4, 7, and 10 seconds for the Adjacent Summed Delays, and 3 degrees per second for the corrective maneuver turn rate. The blunder recovery area for all possible combinations of these parameter values can be obtained from the results of the analysis.

The blunder data, excluding the DAS error, for the dual aircraft analysis is presented in tabular form in Appendix D, and typical output data from the dual aircraft analysis is contained in Table 3.3-3, where the column headings are explained as follows:

Blundered Departure Angle (deg.) - the angle at which a blundered aircraft heads toward the adjacent approach course measured from the extended runway centerline.

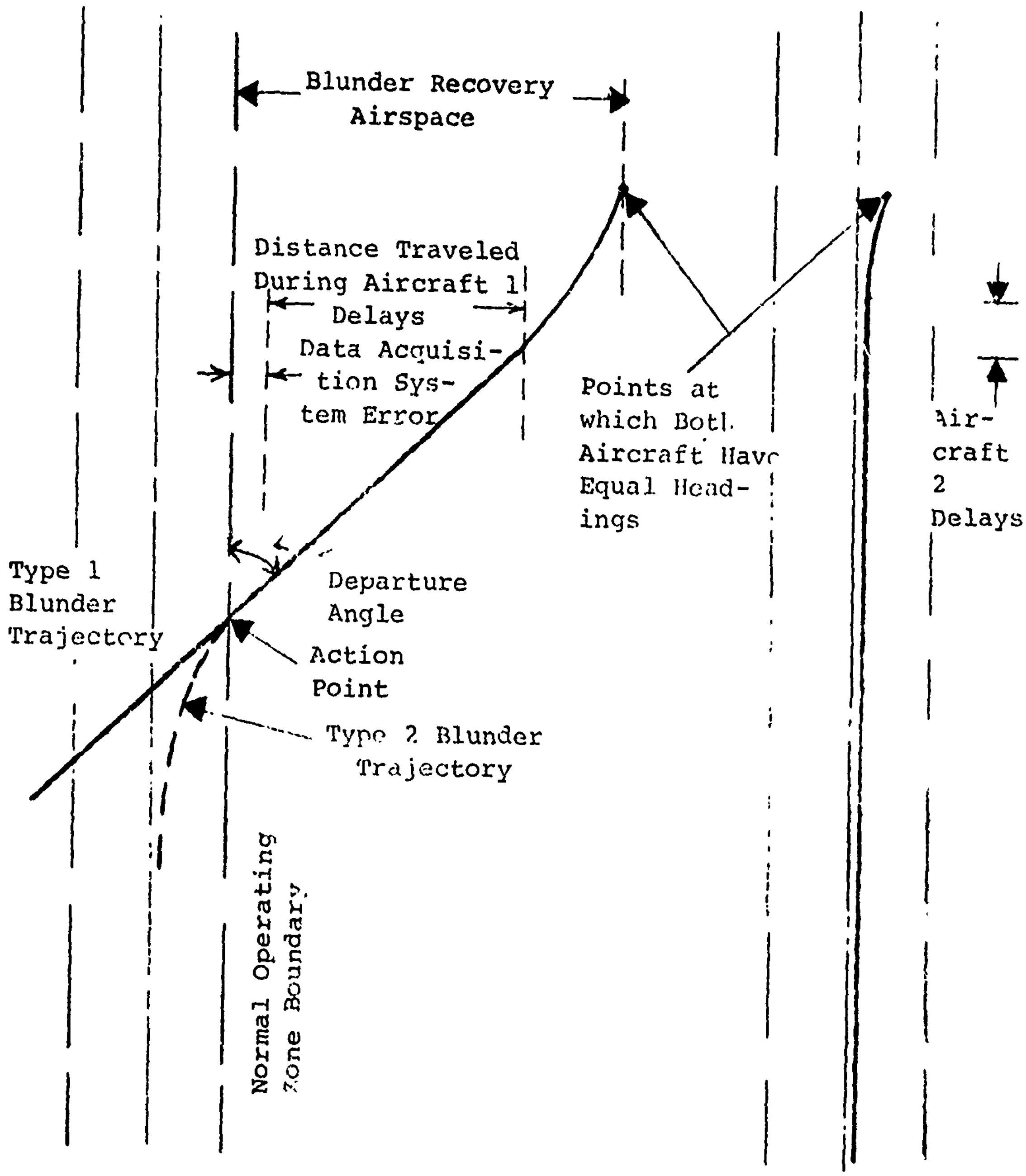


Figure 3.3-3 Dual Aircraft Geometric Analysis

Table 3.3-3 Dual Aircraft Blunder Data

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
30.00	100.00	40.00	2.50	1.00	174.87	5.21	346.00
30.00	100.00	40.00	2.50	4.00	180.00	5.77	352.23
30.00	100.00	40.00	2.50	7.00	180.00	5.77	352.23
30.00	100.00	40.00	2.50	10.00	180.00	5.77	352.23
30.00	100.00	40.00	9.00	1.00	174.87	11.71	896.54
30.00	100.00	40.00	9.00	4.00	180.00	12.27	900.77
30.00	100.00	40.00	9.00	7.00	180.00	12.27	900.77
30.00	100.00	40.00	9.00	10.00	180.00	12.27	900.77
30.00	100.00	40.00	16.00	1.00	174.87	18.71	1487.27
30.00	100.00	40.00	16.00	4.00	180.00	19.27	1491.50
30.00	100.00	40.00	16.00	7.00	180.00	19.27	1491.50
30.00	100.00	40.00	16.00	10.00	180.00	19.27	1491.50
30.00	100.00	40.00	22.00	1.00	174.87	24.71	1993.61
30.00	100.00	40.00	22.00	4.00	180.00	25.27	1997.84
30.00	100.00	40.00	22.00	7.00	180.00	25.27	1997.84
30.00	100.00	40.00	22.00	10.00	180.00	25.27	1997.84
30.00	100.00	30.00	2.50	1.00	172.37	6.04	402.69
30.00	100.00	30.00	2.50	4.00	173.47	7.01	415.72
30.00	100.00	30.00	2.50	7.00	180.00	7.25	416.27
30.00	100.00	30.00	2.50	10.00	180.00	7.25	416.27
30.00	100.00	30.00	9.00	1.00	172.37	12.54	951.23
30.00	100.00	30.00	9.00	4.00	178.47	13.51	964.26
30.00	100.00	30.00	9.00	7.00	180.00	13.75	964.80
30.00	100.00	30.00	9.00	10.00	180.00	13.75	964.80
30.00	100.00	30.00	16.00	1.00	172.37	19.54	1541.96
30.00	100.00	30.00	16.00	4.00	178.47	20.51	1554.99
30.00	100.00	30.00	16.00	7.00	180.00	20.75	1555.54
30.00	100.00	30.00	16.00	10.00	180.00	20.75	1555.54
30.00	100.00	30.00	22.00	1.00	172.37	25.54	2046.30
30.00	100.00	30.00	22.00	4.00	178.47	26.51	2061.33
30.00	100.00	30.00	22.00	7.00	180.00	26.75	2061.88
30.00	100.00	30.00	22.00	10.00	180.00	26.75	2061.88

Blundered Velocity (knots) - the velocity of the blundered aircraft.

Blundered Bank Angle (deg.) - the bank angle that the blundered aircraft uses to make the corrective maneuver.

Blundered Summed Delays (sec.) - a total of all the delays of the blundered aircraft, including DAS Update Delay, Communication Time, and Pilot/Aircraft Reaction Time.

Adjacent Summed Delays (sec.) - a total of all the delays of the adjacent aircraft, including Communication Time and Pilot/Aircraft Reaction Time measured after the Blundered Summed Delays.

Corrected Parallel Headings (deg.) - the heading angle of both the blundered and adjacent aircraft at the point in time when they are flying parallel courses (i.e., the blunder is corrected). The approach (runway) heading was arbitrarily assumed to be 180^{o}.

Blunder Correction Time (sec.) - the total time required for a blundered aircraft to attain a flight course parallel with that of the aircraft on the adjacent course (total blunder recovery time measured from the time the blundered aircraft reaches the action point until the blunder is corrected).

Blunder Recovery Airspace (ft.) - the lateral recovery airspace, excluding EDAS, required for a blundered aircraft to recover to a course parallel with that of the adjacent aircraft. The blunder recovery airspace is measured from the action point perpendicular to the extended runway centerline.

To utilize the dual aircraft analysis data contained in Appendix D, the desired set of blundered aircraft parameter values to be studied must first be selected from Table 3.3-1. For the purpose of illustration, assume the desired set of values to be as follows:

Departure Angle	- 30 degrees
DAS Range Accuracy (ε_R)	- .5 percent of range
DAS Azimuth Accuracy (ε_A)	- 1.0 degree
DAS Update Delay	- 1 second
Aircraft Velocity	- 100 knots
Aircraft Bank Angle	- 30 degrees
Pilot/Aircraft Reaction Time	- 5 seconds

Communication Time - 4 seconds

Also, assume the Adjacent Summed Delays to be 2 seconds.

First, find the departure angle (30 degrees) in the dual aircraft blunder data table (Table 3.3-3). The aircraft velocity (100 knots) and the aircraft bank angle (30 degrees) can now be found in the appropriate columns. Sum the DAS update delay (1 second), the pilot/aircraft reaction time (5 seconds), and the communication time (4 seconds) to yield the blunder summed delay (10 seconds). This summed delay value falls between two values (9 seconds and 16 seconds) in the Blundered Summed Delay output column. Since the delays of the adjacent aircraft (2 seconds) falls between two values (1 second and 4 seconds) in the Adjacent Summed Delays output column, the desired blunder recovery airspace (1,039.96 feet) can be found by a double linear interpolation, between the two sets of recovery airspaces (951.23 feet and 964.26 feet) and (1,541.96 feet and 1,554.99 feet).

It should be noted that the blunder recovery airspace of Appendix D does not include the Data Acquisition System error (EDAS). However, the value of EDAS may be calculated by using the identical technique explained previously for the single aircraft blunder analysis. By using the desired values of ε_R (.5 percent of range) and ε_A (1 degree) and by using the same assumed EDAS location parameters as used in the illustrative example for the single aircraft blunder analysis, the value of EDAS is 101.17 feet.

Upon finding the value of EDAS (101.17 feet), it may be added to the blunder recovery airspace (1,039.96 feet) to find the total airspace required (1,141.13 feet) for an aircraft to recover from the defined blunder condition.

SECTION 4

RUNWAY SPACING DETERMINATION

By minimizing runway lateral spacings, terminal IFR operational capacity can be increased. The objective of the Lateral Separation Study is to provide a means for establishing the feasibility of minimizing runway spacings for the purpose of increasing operational capacity. This objective is accomplished by providing methods for determining the minimum lateral spacing between runways and for measuring the relative safety for a given runway spacing. In addition to minimizing runway spacings, it is also necessary to consider the situation where the runway spacings are fixed. This situation could exist for the case where the runways have already been constructed or where new airport design goals dictate fixed runway locations. In these cases, it is necessary to provide a method for identifying acceptable operations and for determining relative safety. The purpose of this section is to present these methods.

The methods described in this section are valid for the approach configurations listed in Table 4-1. These methods are based upon the following:

1. no transgression zone,
2. normal operating zones,
3. probability of collision,
4. blunder recovery airspace, and
5. system biases

The no transgression zone is a constant lateral distance which is specified by procedures. Normal operating zone data is provided in Appendix A and discussed in Section 3.1. This data was generated as described in Section 2.5. Relative safety measurement capability is provided by the probability of collision data, which is presented in Appendix B and discussed in Section 3.2. This data was generated as described in Section 2.6. The generation of the blunder recovery data, presented in Appendices C and D, is described in Section 2.7. Section 3.3 provides a discussion of the data and presents procedures which describe how to use the data. The effect of measurable or known system biases due to equipment biases and/or operational constraints is also included in the runway spacing determination. Once a runway spacing is determined, the increase or decrease in lateral airspace required due to the biases can be added to or subtracted from the previous value for the

Table 4-1

Approach Configurations
Parallel Runways:
CTOL/CTOL-Independent
FC/FC
FC/BC
FC/VOR
CTOL/CTOL-Dependent-FC/FC
Longitudinal Separation of 3 NMi
Longitudinal Separation of 2 NMi
Longitudinal Separation of 1 NMi
Longitudinal Separation of .25 NMi
CTOL/STOL-Independent-FC/FC
Threshold Displacement of 0 feet
Threshold Displacement of 3000 feet
Threshold Displacement of 6000 feet*
STOL/STOL-Independent-FC/FC
Skewed Runways:
CTOL/STOL-Independent-FC/FC-3000 foot Threshold Displacement
Skew Angle of 10°
Skew Angle of 20°
Skew Angle of 30°
Skew Angle of 40°
Skew Angle of 50°
Skew Angle of 60°
Skew Angle of 70°
Skew Angle of 80°
Skew Angle of 90°

*Considered the same as the zero threshold displacement case due to departure considerations.

runway spacing.

In order to determine minimum runway spacings, standards must exist or be determined to which comparisons will be made. Among the parameters involved in the runway spacing determination, one of the more important is the probability of collision because it relates to the "relative" safeness of a specific approach configuration. One way of establishing a

relative probability of collision standard can be accomplished by determining the probability of collision for the existing minimum runway spacing criteria and relating the probability of collision for other runway spacings to this standard.

A possible data set to use in establishing a standard would be the 1961/1969 Chicago data. The 1961 data set was collected at Chicago's O'Hare airport and was considered in the development of the current 5000 foot lateral spacing criteria. The 1969 data set was also collected at Chicago's O'Hare airport and was considered in the revalidation of the 5000 foot lateral spacing criteria. The 1961 data results in a probability of collision of $.99 \times 10^{-5}$ for an approach configuration at Chicago O'Hare (CTOL/CTOL-parallel-independent-FC/FC) for a 5000 foot lateral runway separation, at the range interval between 6 and 6.5 NMi. In 1969, the same approach configuration had a probability of collision value of $.23 \times 10^{-8}$. These two probability of collision numbers not only indicate the trend toward safer operations, but also yield a relative basis for comparing new runway spacings and approach configurations. The 1961 and 1969 probability of collision data at Chicago was based on a modified Burgerhout distribution fit to the measured distribution data standard deviation in the lateral dimension and worst case conditions in the vertical and longitudinal dimensions. These probabilities of collision can be compared directly only to probability of collision values based on the same worst case conditions; i.e., the CTOL/CTOL and STOL/STOL independent parallel cases.

The worst case conditions for all parallel approach configurations considered in this study are shown in Table 4-2. Also shown in this table are the range of probability of collision values for each case. The relative magnitude of these values may be useful in determining relative standards for the various approach configurations.

The operations pertinent to minimum runway spacing determination can be categorized as either approaches, departures, or missed approaches. The normal operating zone and probability of collision are approximately the same for approaches and departures; therefore, the calculation of runway spacing is independent of whether the operation is an approach or a departure. The missed approach case can be evaluated as either a departure or a blundered aircraft. That is, if the

Table 4-2

Dimensional Distributions for Specific Parallel Approach Configurations

Operation	Dimension			Range of Probability of Collision
	Lateral	Vertical	Longitudinal	
CTOL/CTOL Independent STOL/STOL Independent	Fokker-Planck/ Fokker-Planck	Coincident	Coincident	10^{-2} to 10^{-36}
CTOL/CTOL Dependent	Fokker-Planck/ Fokker-Planck	Coincident	Gaussian/ Gaussian	10^{-3} to 10^{-81}
CTOL/STOL Independent	Fokker-Planck/ Fokker-Planck	Gaussian/ Gaussian	Coincident	10^{-11} to 10^{-50}

missed approach is executed within the NOZ, then the aircraft may be treated as a departure. If while executing a missed approach the aircraft goes outside of the NOZ, then the aircraft has become a blundered aircraft and is treated using the deterministic techniques discussed in Section 2.7.

As shown in Table 4-1, both parallel and skewed runways are considered. Methods are provided for determining minimum lateral runway spacing requirements for parallel runways in Section 4.1 and for skewed runways in Section 4.2. Two methods are provided for both cases:

1. fixed runway location method, and
2. non-fixed runway location method.

4.1 LATERAL RUNWAY SPACING FOR PARALLEL OPERATIONS

The methods described in this section provide the capability of determining minimum lateral runway spacing for the parallel approach configurations listed in Table 4-1. Also, these methods allow fixed runway spacings to be analyzed to identify acceptable operations and to determine relative safety. The methods presented may be used in conjunction with a trade-off analysis to obtain the desired results. This allows decisions to be made based upon several alternatives. As illustrated in Table 4.1-1, the trade-off analysis includes the following items:

1. approach configuration,
2. NOZ type (68% or 95%),
3. blunder recovery maneuver type (single or dual aircraft),
4. runway spacing,
5. probability of collision,
6. blunder recovery airspace, and
7. blunder recovery parameters.

Before a final decision is made concerning minimum runway spacing requirements for a particular situation, all possible alternatives should be investigated. This is accomplished by completing Table 4.1-1 for all approach configurations considered. The steps taken to complete this table are discussed below.

First, the types of parallel approach configurations to be considered are selected. Then the no transgression zone (NTZ) is specified and the lateral spacing due to system biases determined. For each of the approach configurations selected, four sets of values are determined for the various combinations of NOZ's and blunder recovery maneuvers available.

Table 4.1-1 Minimum Runway Spacing Trade-off Analysis Table

(a) 68% NOZ and Single Aircraft Blunder Recovery

No Transgression Zone = ________ feet   System Biases = ________ feet

Parallel Approach Configuration	Runway Spacing, feet	Probability of Collision	Blunder Recovery Airspace, feet	Blunder Recovery Parameters
CTOL/CTOL Independent FC/FC FC/BC FC/VOR				
CTOL/CTOL Dependent FC/FC w. LS*of 3 NMi FC/FC w. LS of 2 NMi FC/FC w. LS of 1 NMi FC/FC w. LS of .25 NMi				
CTOL/STOL Independent FC/FC w. No TD** FC/FC w. 3000' TD				
STOL/STOL Independent FC/FC				

* Longitudinal separation
**Threshold displacement

Table 4.1-1 Minimum Runway Spacing Trade-off Analysis Table

(b) 68% NOZ and Dual Aircraft Blunder Recovery

No Transgression Zone = ________ feet System Biases = ________ feet

Parallel Approach Configuration	Runway Spacing, feet	Probability of Collision	Blunder Recovery Airspace, feet	Blunder Recovery Parameters
CTOL/CTOL Independent FC/FC FC/BC FC/VOR				
CTOL/CTOL Dependent FC/FC w. LS* of 3 NMi FC/FC w. LS of 2 NMi FC/FC w. LS of 1 NMi FC/FC w. LS of .25 NMi				
CTOL/STOL Independent FC/FC w. No TD** FC/FC w. 3000' TD				
STOL/STOL Independent FC/FC				

* Longitudinal separation
**Threshold displacement

Table 4.1-1 Minimum Runway Spacing Trade-off Analysis Table

(c) 95% NOZ and Single Aircraft Blunder Recovery

No Transgression Zone = ________ feet System Biases = ________ feet

Parallel Approach Configuration	Runway Spacing, feet	Probability of Collision	Blunder Recovery Airspace, feet	Blunder Recovery Parameters
CTOL/CTOL Independent FC/FC FC/BC FC/VOR				
CTOL/CTOL Dependent FC/FC w. LS* of 3 NMi FC/FC w. LS of 2 NMi FC/FC w. LS of 1 NMi FC/FC w. LS of .25 NMi				
CTOL/STOL Independent FC/FC w. No TD** FC/FC w. 3000' TD				
STOL/STOL Independent FC/FC				

* Longitudinal separation
**Threshold displacement

Table 4.1-1 Minimum Runway Spacing Trade-off Analysis Table

(d) 95% NOZ and Dual Aircraft Blunder Recovery

No Transgression Zone = ________ feet System Biases = ________ feet

Parallel Approach Configuration	Runway Spacing, feet	Probability of Collision	Blunder Recovery Airspace, feet	Blunder Recovery Parameters
CTOL/CTOL Independent FC/FC FC/BC FC/VOR				
CTOL/CTOL Dependent FC/FC w. LS*of 3 NMi FC/FC w. LS of 2 NMi FC/FC w. LS of 1 NMi FC/FC w. LS of .25 NMi				
CTOL/STOL Independent FC/FC w. No TD** FC/FC w. 3000' TD				
STOL/STOL Independent FC/FC				

* Longitudinal separation
**Threshold displacement

(a) 68% NOZ and single aircraft blunder recovery maneuver,

(b) 68% NOZ and dual aircraft blunder recovery maneuver,

(c) 95% NOZ and single aircraft blunder recovery maneuver, and

(d) 95% NOZ and dual aircraft blunder recovery maneuver.

Once the table of values is completed for all approach configurations being considered, the trade-off analysis is initiated. The analysis consists of evaluating the trade-off's between the elements listed previously based upon the values listed in Table 4.1-1.

Two methods are provided which may be used in conjunction with the trade-off analysis to determine the lateral runway spacing requirements for parallel approach systems. The basic configuration for the parallel approach system case is shown in Figure 4.1-1. The choice of the method to be used is based on the objective or requirement under consideration. If the objective is to analyze minimum spacing requirements for fixed runway spacings, then the fixed runway location method (Section 4.1.1) should be employed. Conversely, if the objective is to analyze minimum spacing requirements for non-fixed runway spacings, then the non-fixed runway location method (Section 4.1.2) should be employed.

Before a method is initiated, it is necessary to obtain the following items:

1. relative safety criteria in terms of probability of collision,
2. restrictions on the blunder recovery parameter values,
3. restrictions on runway lateral spacing,
4. no transgression zone, and
5. system biases.

An acceptable probability of collision criteria is not determined in the Lateral Separation Study; however, one must be specified for each of the operations considered before minimum runway spacing requirements can be determined. Possible methods for determining a relative safety criteria were discussed previously. It is necessary to determine all restrictions on the blunder recovery parameters for each runway in each approach configuration. The blunder recovery parameters are those parameters utilized in the blunder analysis (Section 3.3). Also, it is necessary to determine the runway lateral spacing restrictions, NTZ, and system biases (lateral).

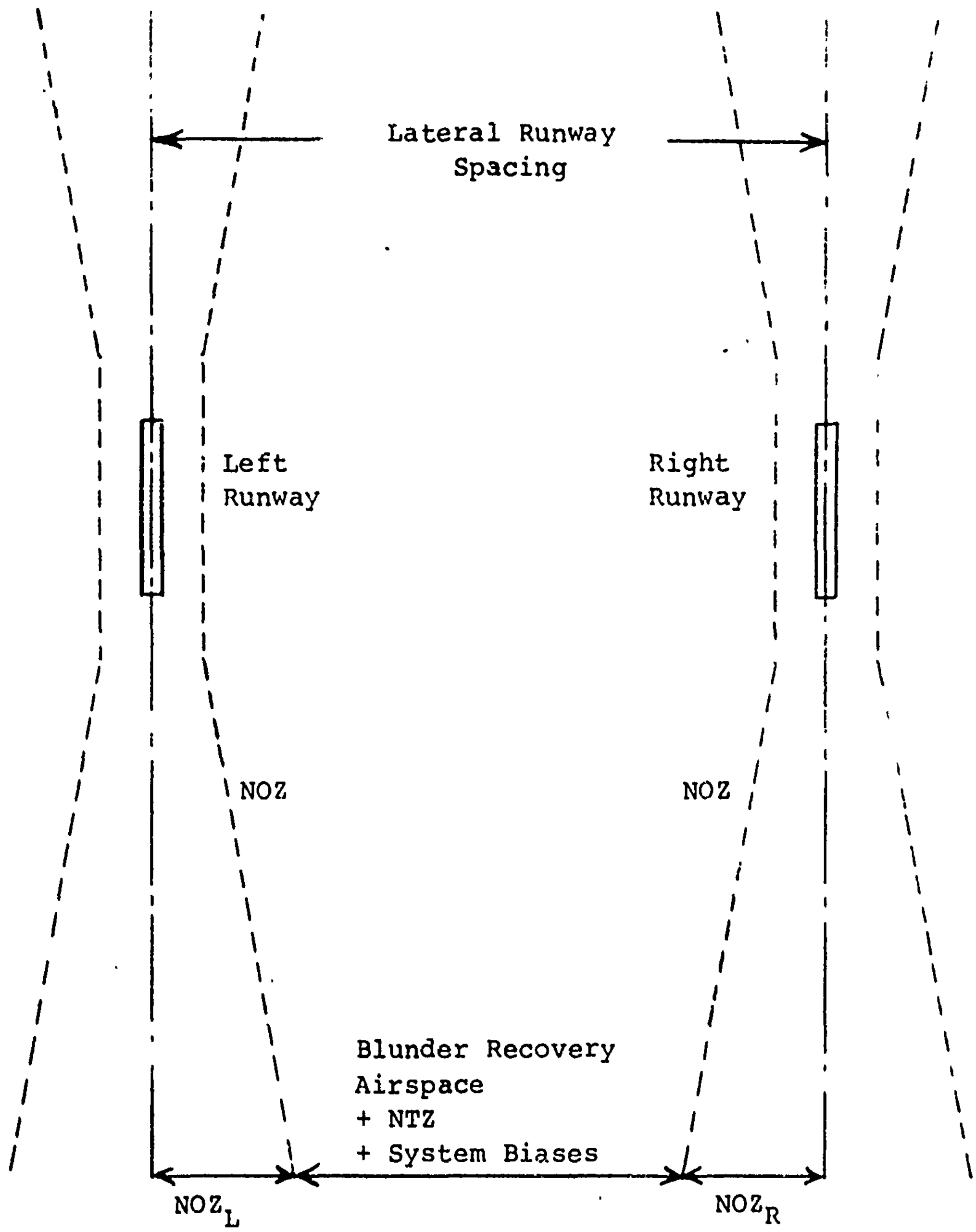


Figure 4.1-1 Parallel Approach Configuration

The data required by these methods consist of the following:

1. probability of collision,
2. normal operating zones, and
3. blunder recovery airspace

which are included in the appendices.

In the following sections, the two methods for determining runway spacing for parallel operations are considered. Flow charts are presented for each method along with a discussion of the process required to move from one block in the flow chart to another.

4.1.1 Fixed Runway Location Method for Parallel Runways

The fixed runway location method should be used when the primary objective is to determine the acceptable approach configurations and blunder recovery parameter values for a fixed runway lateral spacing. This condition could exist for the situation where the runways have already been constructed or where the design goals dictate fixed spacing. By using this method, it is possible to determine the "relative" safety and to determine the blunder recovery parameter values for the parallel approach configurations listed in Table 4-1. In this manner, it is possible to identify the acceptable approach configurations for the fixed runway spacing.

The fixed runway location method is shown in flow chart form in Figure 4.1.1-1. The procedure illustrated in this figure is repeated for all combinations of NOZ types and blunder recovery maneuver types for every approach configuration considered.

The first step i 'ne procedure is to specify the fixed runway spacing. T the probab ty of collision for the approach configuration being considered can be determined from Appendix B. The probability of collision is selected at the range which yields the largest value. If this probability of collision value is not acceptable, then thi approach configuration is not possible for the specified runway spacing. If the probability of collision is acceptable, the procedure is continued.

The next step in the procedure is the determination of the NOZ at the turn-on range for both the left runway (NOZ_L) and the right runway (NOZ_R). These values are determined from the figures in Appendix A. Now the maximum possible blunder recovery area can be determined from the equation below.

$$MBA = RS - NOZ_L - NOZ_R - NTZ - SB$$

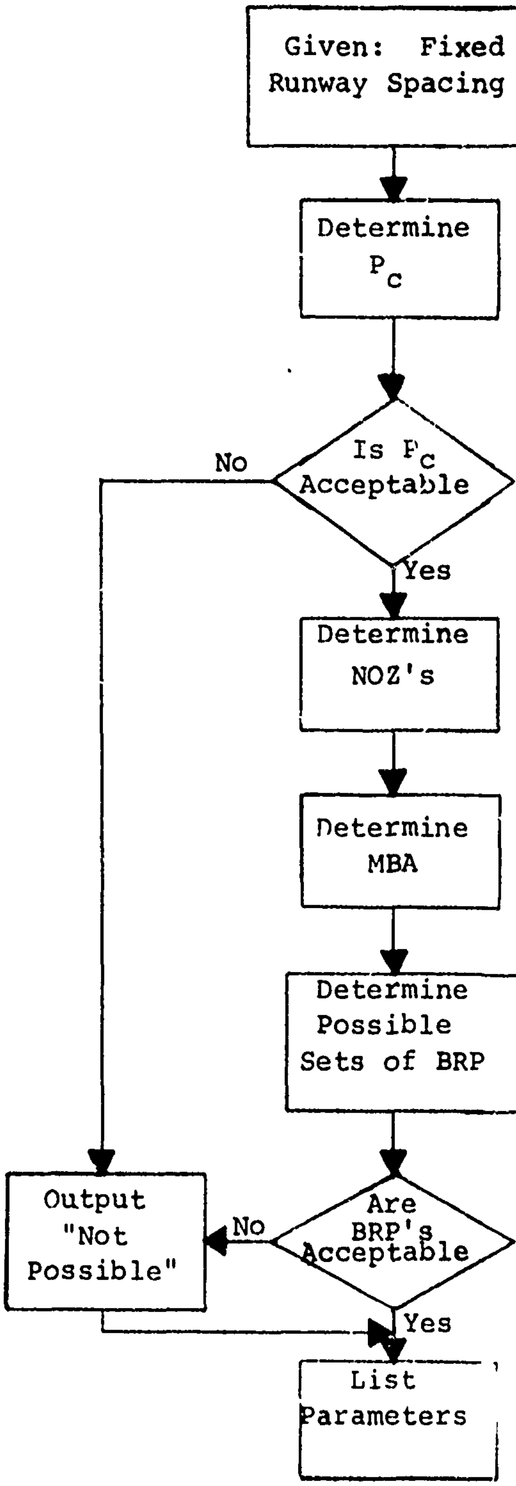


Figure 4.1.1-1 Fixed Runway Location Method for Parallel Runways

where

MBA ~ maximum blunder airspace

RS ~ runway lateral spacing

SB ~ system biases

At this point in the procedure, the various sets of blunder recovery parameter values corresponding to the maximum blunder airspace may be listed using the procedures given in Section 3.3 and the data listed in Appendices C or D. Once these values are listed, the blunder recovery parameter restrictions must be examined for both the left and right runways, and the sets of blunder recovery parameter values which are not acceptable for each runway must be eliminated. If none of the sets of blunder recovery parameter values are acceptable, then this approach configuration is not acceptable for the specified runway spacing. If acceptable blunder recovery parameter sets are found, then the results are entered in Table 4.1-1.

4.1.2 Non-Fixed Runway Location Method for Parallel Runways

When the objective of the analysis is to determine the minimum lateral runway spacing and/or the blunder recovery parameters for non-fixed parallel runways, then the non-fixed runway location method should be employed. This condition could exist for the situation where a new airport is being designed. By using this method, it is possible to determine the minimum lateral separation between parallel runways as well as to measure the relative safety and to determine the blunder recovery parameters for the parallel approach configurations listed in Table 4-1. It is also possible to examine the trade-off's between runway spacing, approach configuration and blunder recovery parameter values.

The non-fixed runway location method is shown in Figure 4.1.2-1. The procedure illustrated in this figure is repeated for all combinations of NOZ type and blunder recovery maneuver type for every approach configuration considered.

In Figure 4.1.2-1, the first step is to initialize the runway spacing. Then, using Appendix B, the corresponding probability of collision (largest value) for the specific approach configuration and runway spacing is determined. If this value for the probability of collision is not acceptable, then the runway spacing is increased and the process repeated. Once an acceptable probability of collision is found, the NOZ's at the turn-on range for both the right and left runways are

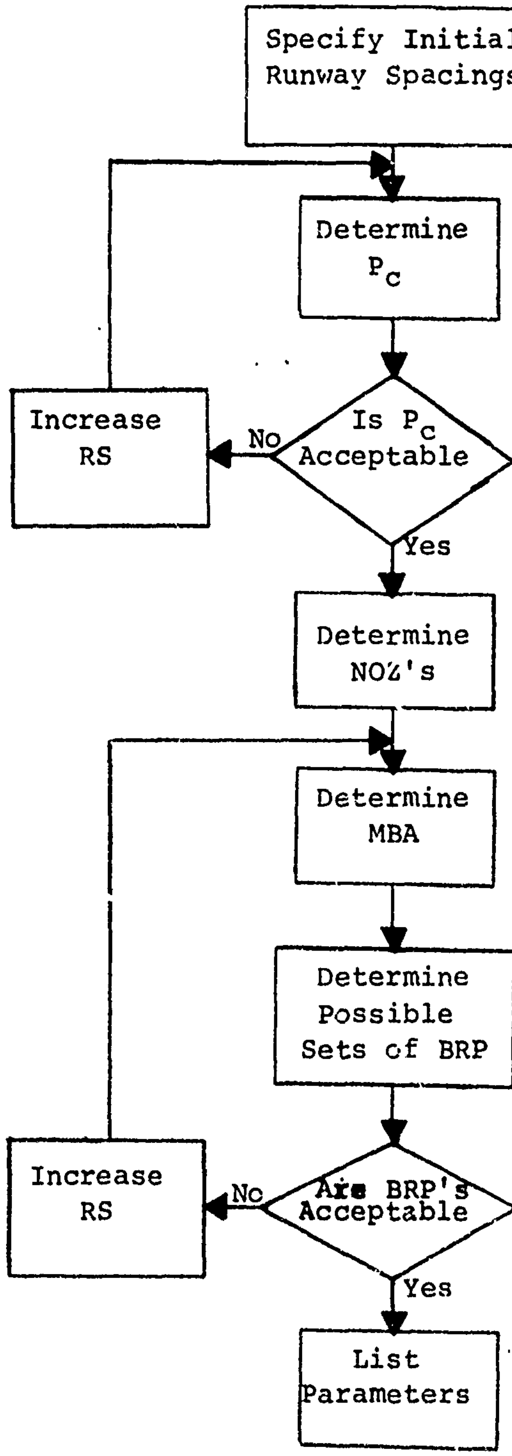


Figure 4.1.2-1 Non-Fixed Runway Location Method for Parallel Runways

determined using Appendix A. The NOZ's, NTZ, and system biases are then subtracted from the runway spacing value to determine the maximum blunder recovery area.

$$MBA = RS - NOZ_L - NOZ_R - NTZ - SB$$

Using this value for the blunder recovery area, the possible blunder recovery parameter values can be determined from the procedures in Section 3.3 and by using either Appendix C or D depending on whether single or dual aircraft maneuvers are being considered. If an acceptable set of blunder recovery parameter values does not exist for both the right and left runways, then the runway spacing is increased and the process repeated. This procedure continues until an acceptable blunder recovery parameter set is determined. When this is accomplished, the resultant runway spacing is the minimum runway spacing for the specified approach configuration, NOZ type, and blunder recovery maneuver type. The runway spacing value, probability of collision, NOZ, blunder recovery area, and blunder recovery parameter values are then listed in Table 4.1-1.

4.2 RUNWAY SPACING FOR SKEWED OPERATIONS

The capability of determining minimum runway spacing for the CTOL/STOL skewed approach configurations listed in Table 4-1 is provided by the methods described in this section. These methods also allow fixed runway locations to be analyzed to determine acceptable blunder recovery parameter values. Two methods are provided which may be used to determine the runway spacing requirements for CTOL/STOL skewed runways:

1. fixed runway location method and
2. non-fixed runway location method.

The choice of the method to be used is dependent upon whether the runway locations are fixed or not, as the titles imply.

These methods are very similar to the methods discussed for parallel runways; therefore, much of the discussion in Section 4.1 is valid for this section. The basic difference in the two methods is that probability of collision values were not determined for the skewed case due to the unavailability of measured data to verify the STOL curved departure distribution data. The minimum runway spacing requirements for the skewed case are based upon the data at only one point, i.e., the minimum separation point between the CTOL runway and the STOL departure path. This point is selected because it represents the most critical point

in the skewed configuration. The data consists of normal operating zone data and blunder recovery airspace data.

The CTOL/STOL skewed runway configuration is illustrated in Figure 4.2-1. Note that this configuration is dependent upon the skew angle (α) and the specific operations noted, i.e., a STOL nominal departure velocity of 73 knots and a standard rate turn through the curved path. The results obtained from this method are valid only for the specific operations noted; however, different operations could be investigated using similar techniques.

Before a method is initiated, it is necessary to obtain the following items:

1. restrictions on the blunder recovery parameters,
2. restrictions on the runway location,
3. no transgression zone, and
4. system biases.

The restrictions on the blunder recovery parameters must be determined for each runway. Runway location restrictions pertinent to spacing as well as skew angle must be determined. The no transgression zone must be determined at the point of minimum separation. The system biases and their effect upon the runway spacing must be determined for both runways.

4.2.1 Fixed Runway Location Method for Skewed Runways

When a fixed runway location exists for CTOL/STOL skewed runways, the method shown in Figure 4.2.1-1 should be employed. The procedure illustrated in this figure is repeated for all combinations of NOZ type and blunder recovery maneuver type.

The first step in the procedure is to specify the fixed runway spacing and skew angle. Then the STOL NOZ (NOZ_{STOL}) for the skew angle being considered is determined from Appendix A. The NOZ for the CTOL runway (NOZ_{CTOL}) is determined at a range equal to R_1 from Appendix A, where

$$R_1 = 2440 \sin\alpha + 6200 \cos\alpha - 5000, \text{ feet.}$$

Now the maximum possible blunder recovery area can be determined from the equation below:

$$MBA = RS - NOZ_{CTOL} - NOZ_{STOL} - NTZ - SB - D_1 - D_2$$

where

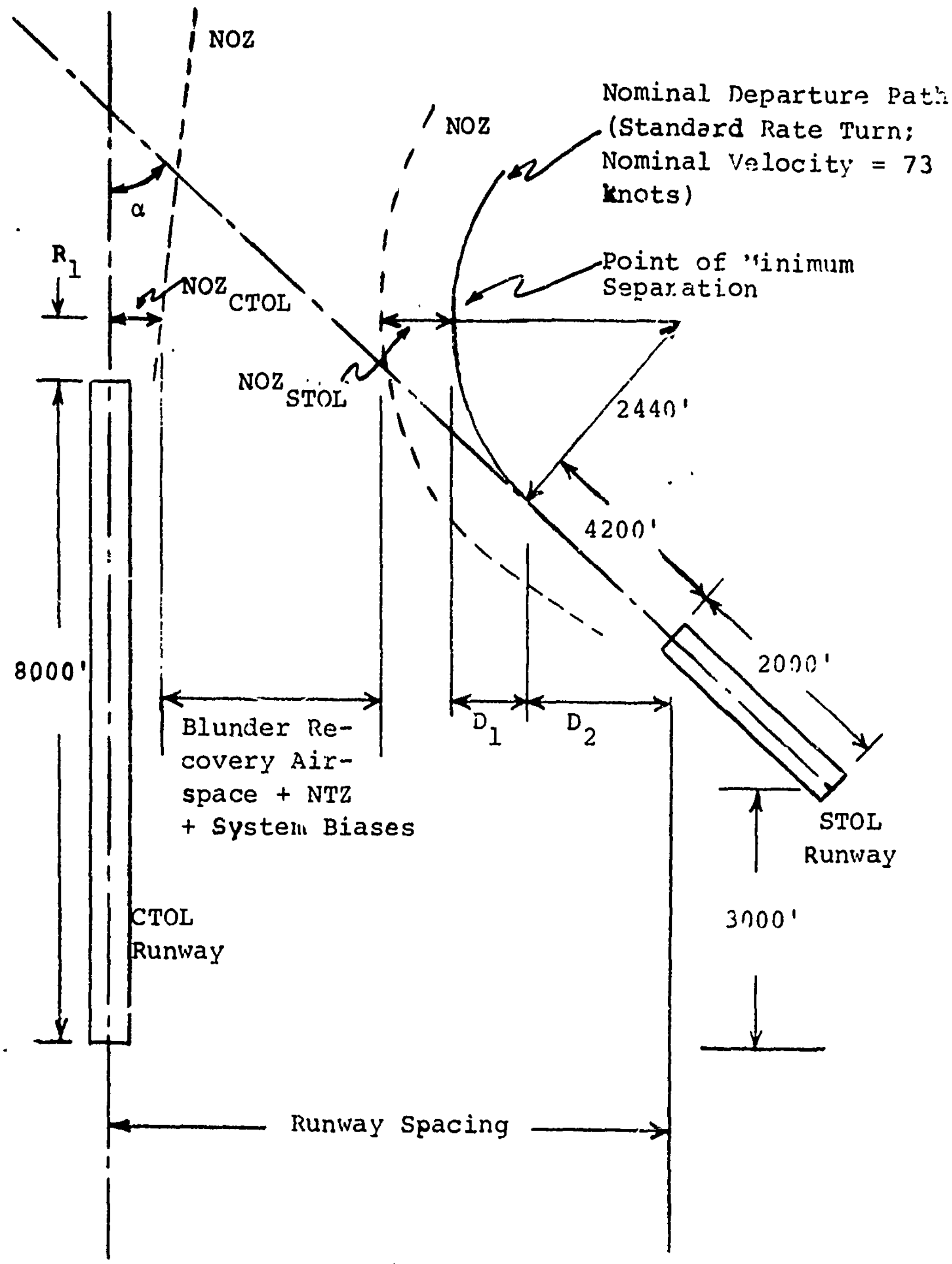


Figure 4.2-1 CTOL/STOL Skewed Runway Configuration

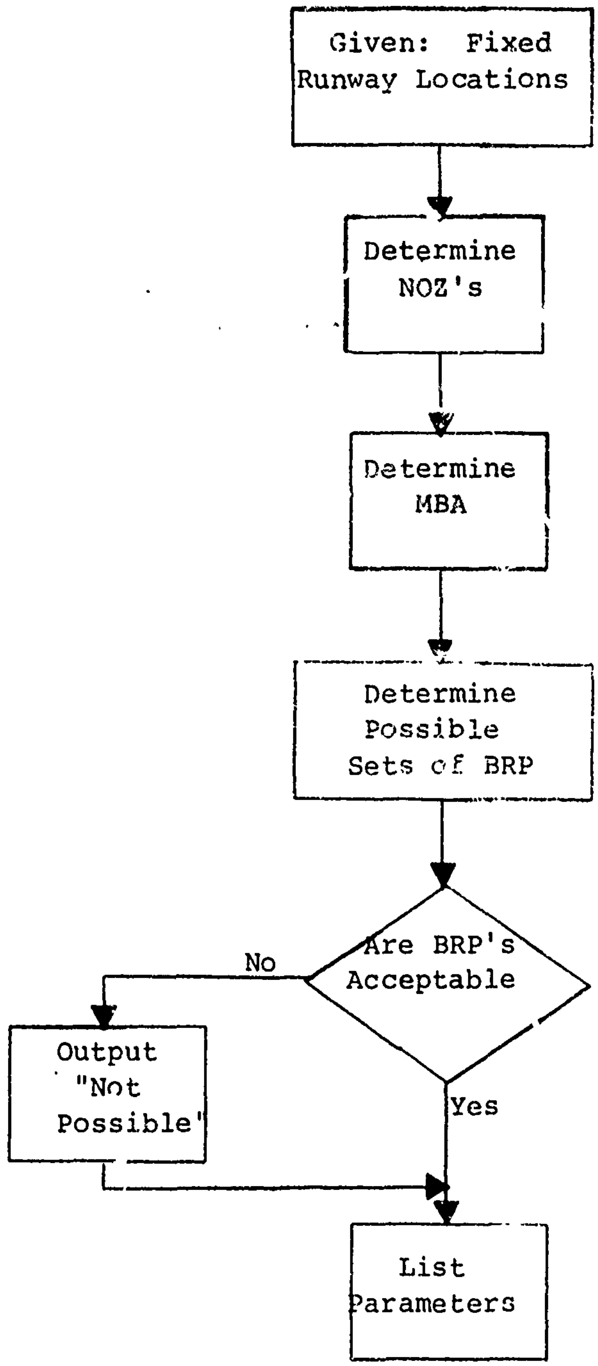


Figure 4.2.1-1 Fixed Runway Location Method for Skewed Runways

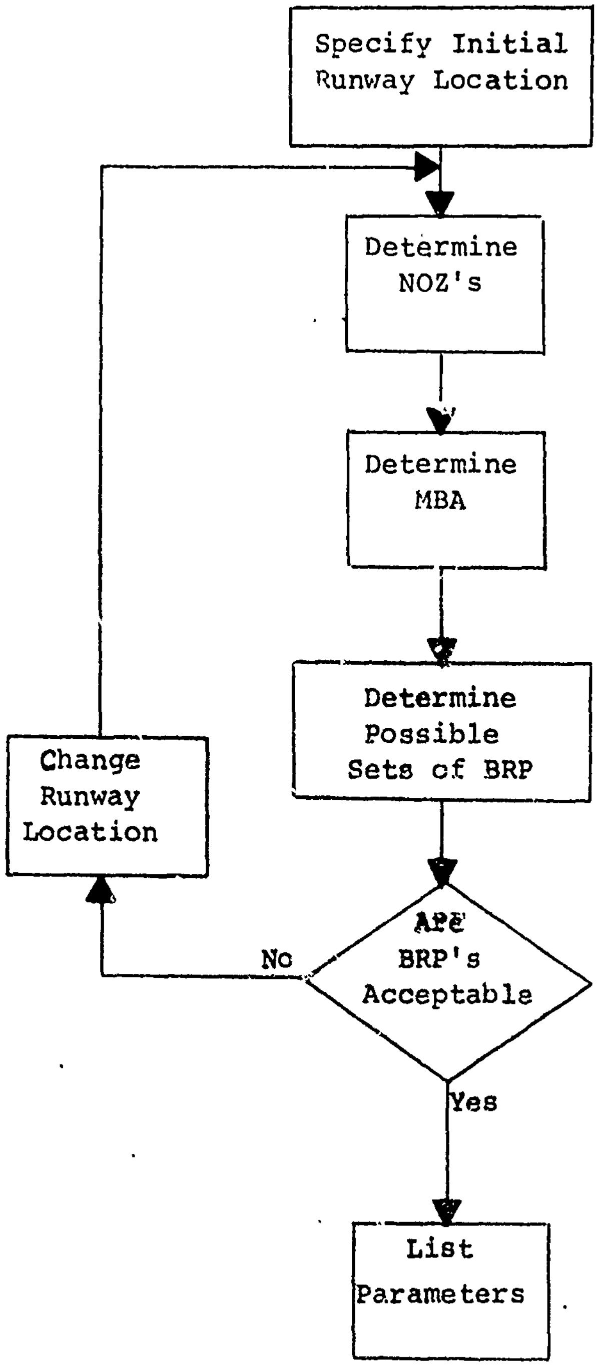


Figure 4.2.2-1 Non-Fixed Runway Location Method for Skewed Runways

$D_2 = 4200 \sin\alpha$, feet.

Using MBA, the possible blunder recovery parameter values can be determined from Appendix C or D and the procedures in Section 3.3. If an acceptable set of blunder recovery parameters does not exist for both the CTOL and the STOL runways, then the runway location must be changed slightly by either increasing the runway spacing or decreasing the skew angle or both. Once the change in the runway location has been accomplished, then the process is repeated. This procedure continues until an acceptable blunder recovery parameter set is determined. When this is accomplished, the resultant minimum runway spacing is determined, and the blunder parameter values are noted.

After the values for all combinations of NOZ type and blunder recovery maneuver type have been determined, an analysis of the trade-off's between NOZ type, blunder recovery maneuver type, runway spacing, skew angle, and blunder parameters may be accomplished.

APPENDIX A

NORMAL OPERATING ZONE DATA

Normal operating zone (NOZ) data obtained using the techniques described in the Lateral Separation Study are presented in this appendix. NOZ's are presented for the approach systems listed in Table A-1 and for CTOL/STOL skewed operations. This NOZ data is used in the minimum runway spacing determination.

Table A-1

Figure Numbers for the NOZ's of the Systems Indicated

System	Figure Number
FC-ILS-I-CTOL	A-1
FC-ILS-II-CTOL	A-2
BC-ILS-I-CTOL	A-3
VOR-CTOL	A-4
FC-ILS-I-STOL	A-5

Figures A-1 through A-5 present the NOZ's for the five lateral approach options listed in Table A-1. The five NOZ's are to scale and, therefore, may be compared directly. Table A-2 lists the NOZ's at the minimum distance between the CTOL runway and the STOL departure path, as shown in Figure A-6, for skew angles between 10° and 90° in 10° increments.

Table A-2 CTOL/STOL Skewed NOZ Results

Skew Angle, Degrees	NOZ (68%), feet	NOZ (95%), feet
10	91.35	182.70
20	89.24	178.48
30	93.04	186.08
40	110.55	221.10
50	144.24	288.48
60	191.33	382.66
70	248.07	496.14
80	311.33	632.66
90	378.46	756.92

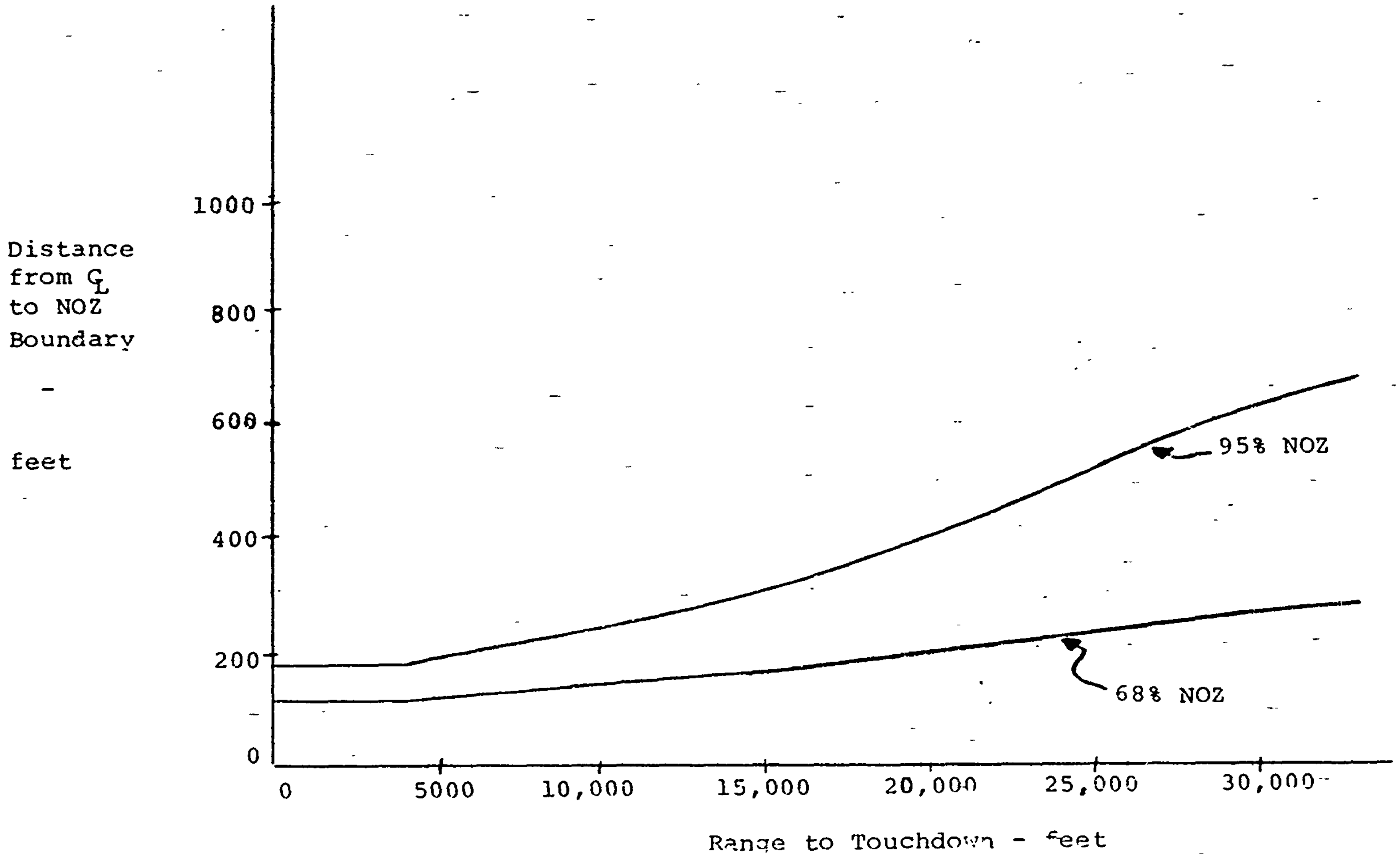


Figure A-1 NOZ Boundaries for FC-ILS-I-CTO

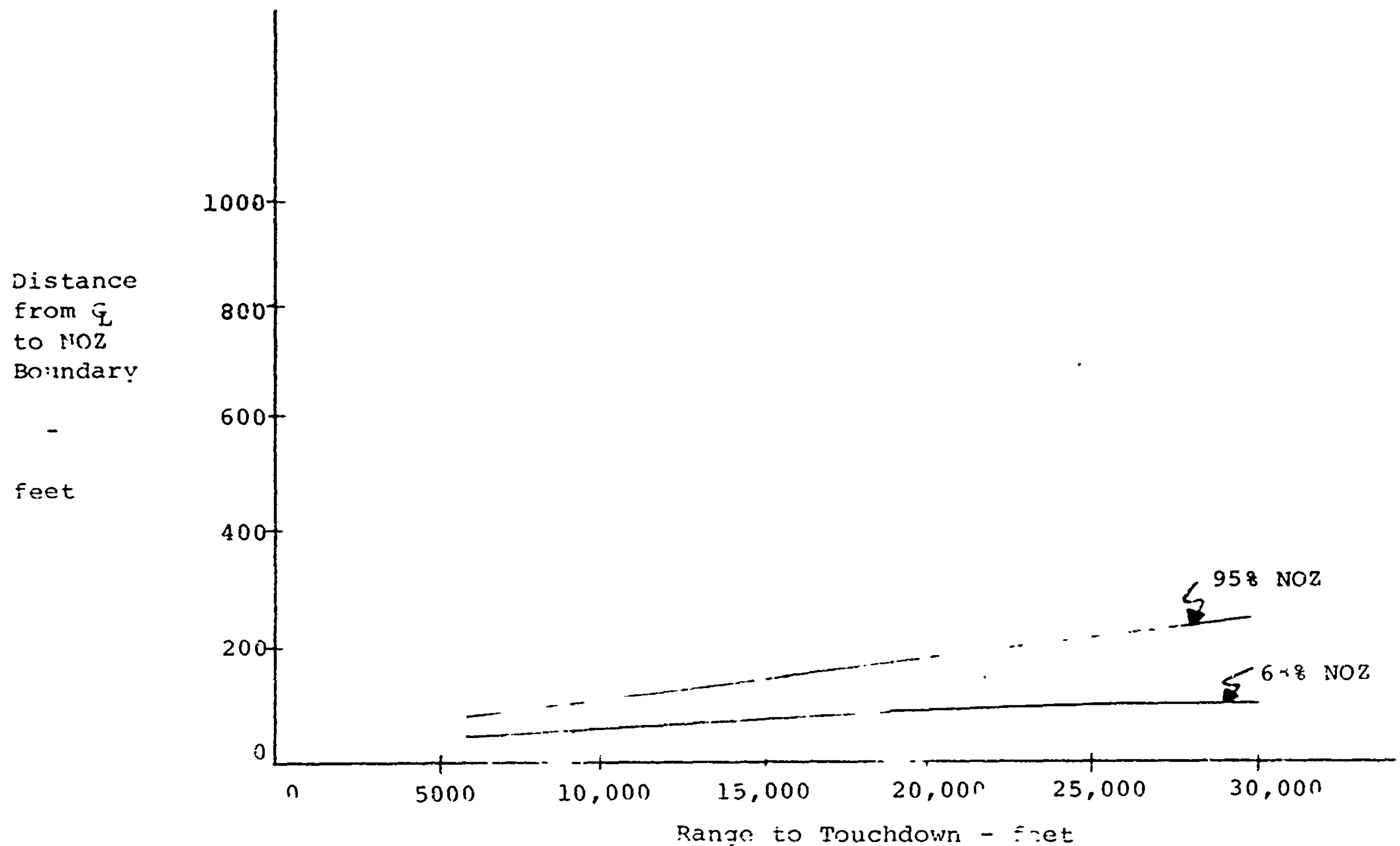


Figure A-2 NOZ Boundaries for -US-II-CTOL

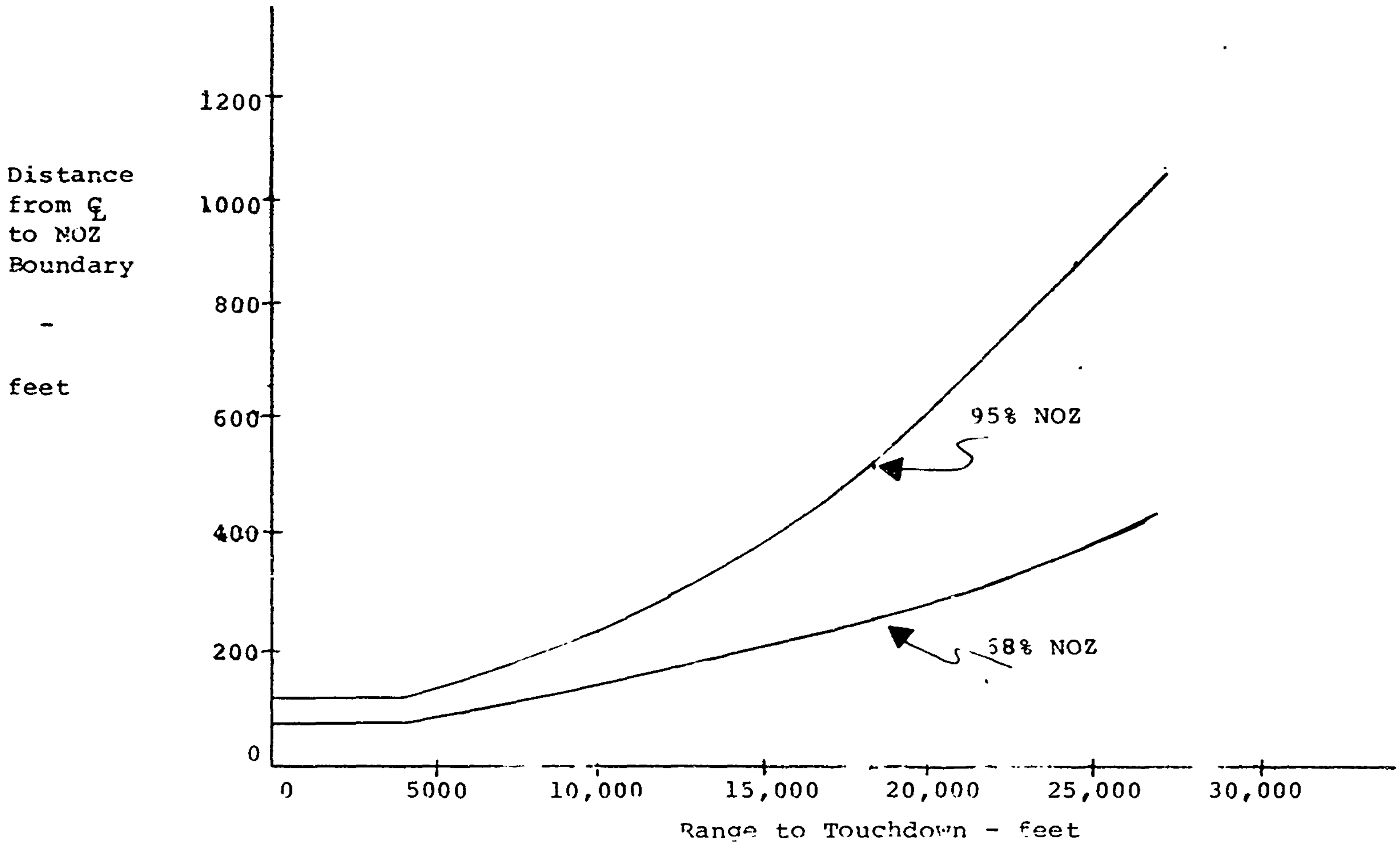


Figure A-3 NOZ Boundaries for BC-ILS-I-CTOL

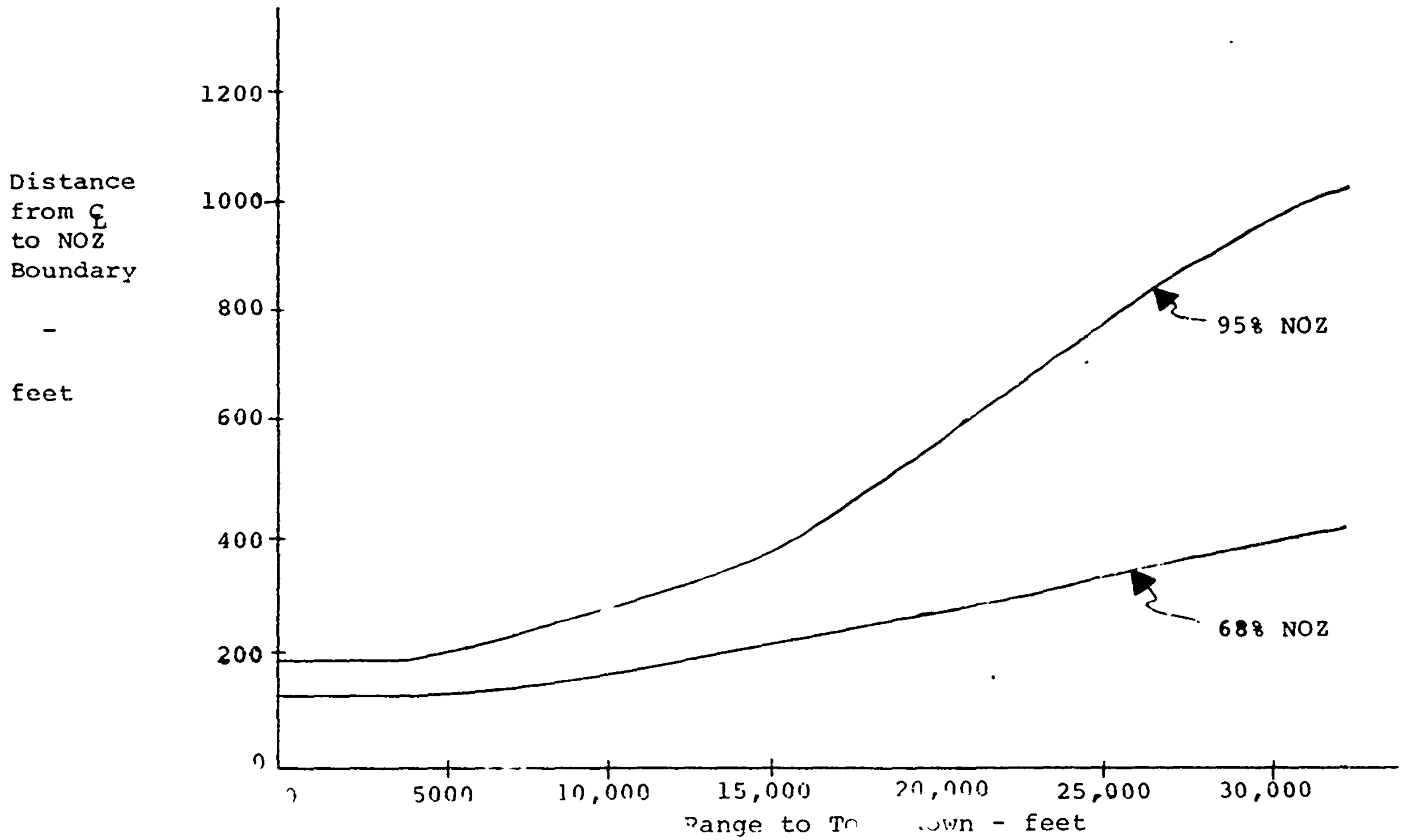


Figure A-4 NOZ Boundaries for VOR-CTOL

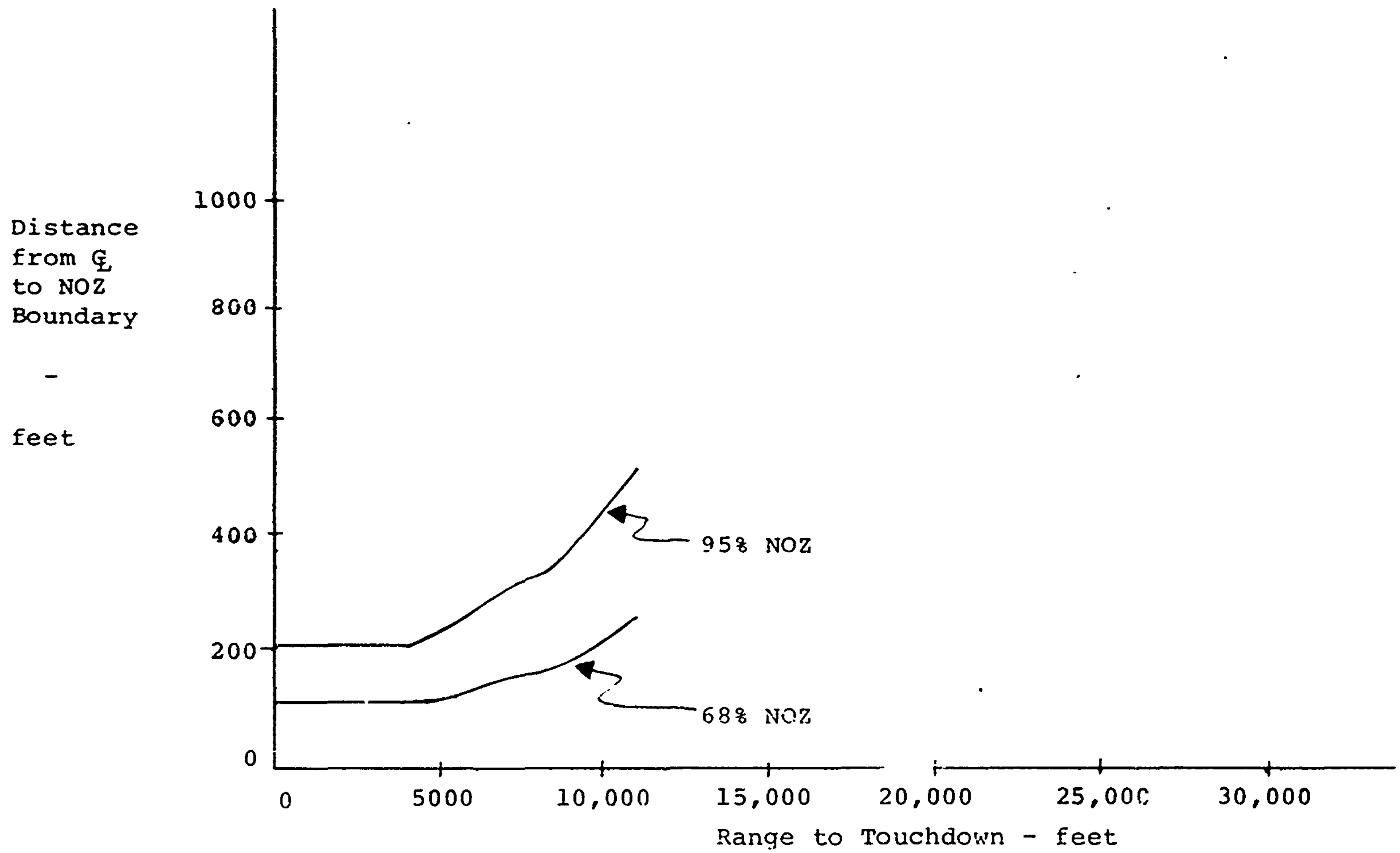


Figure A-5 NOZ Boundaries for FC-ILS-I-STOL

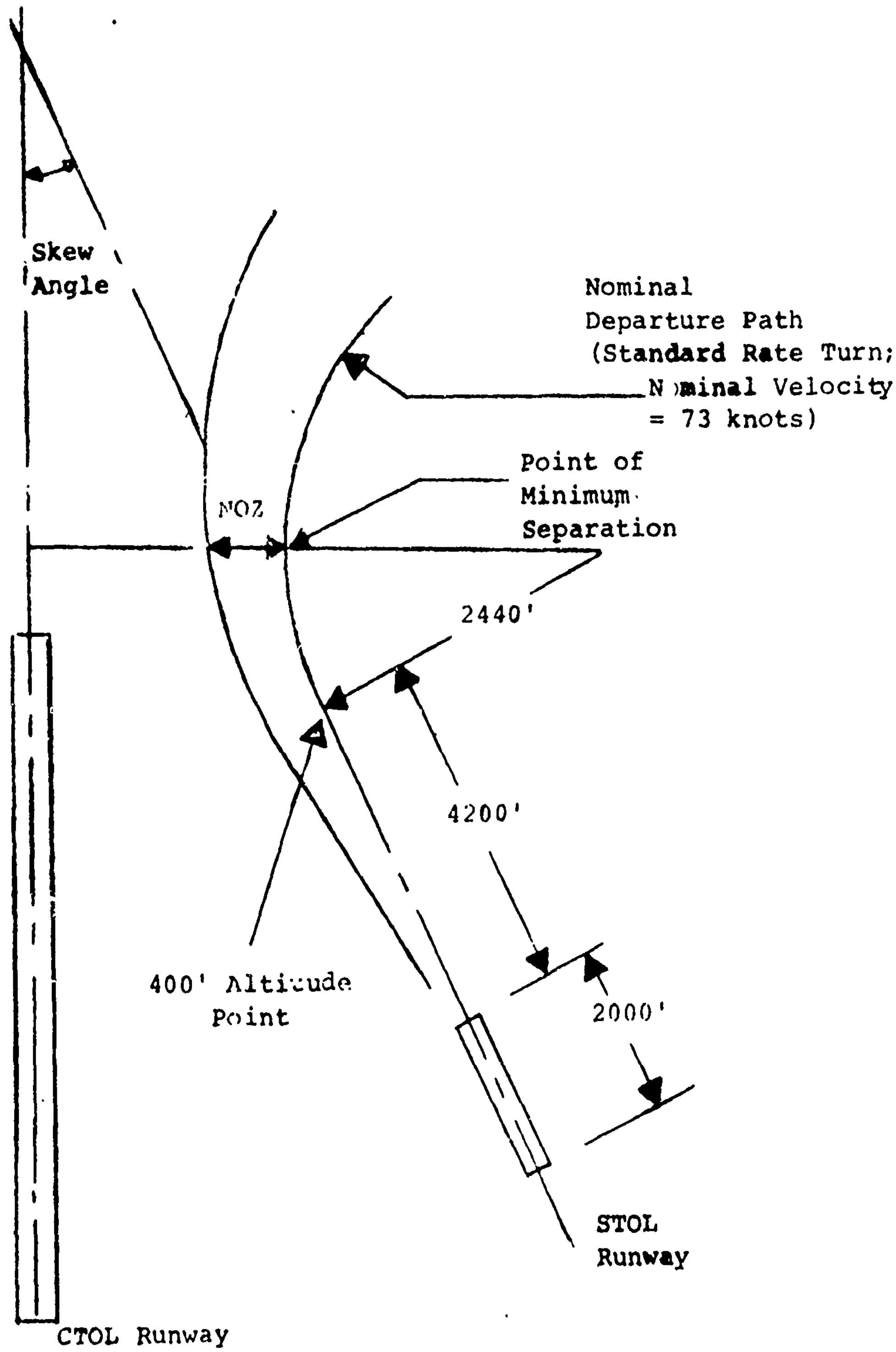
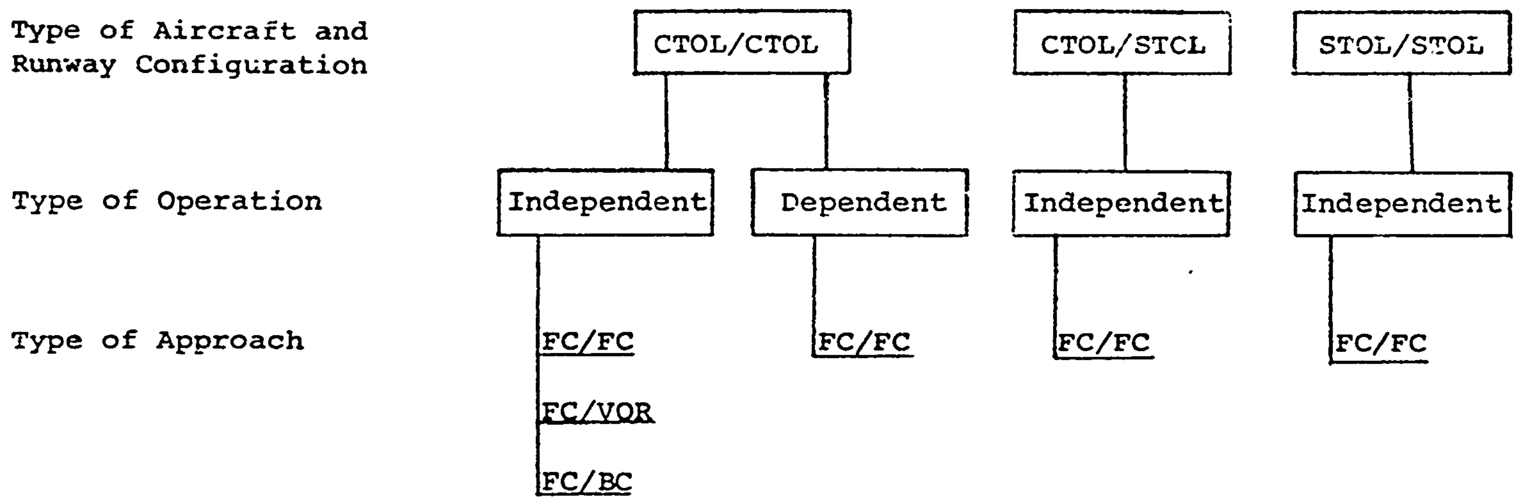


Figure A-6 CTOL/STOL Skewed Geometry

APPENDIX B

PROBABILITY OF COLLISION DATA

Probability of collision results obtained in the Lateral Separation Study are presented in tabular form in this appendix. These results represent a primary output of the Lateral Separation Study and constitute a portion of the information necessary to determine a minimum allowable spacing between parallel runways for aircraft operating under IFR condition. Probability of collision data for CTOL/CTOL, CTOL/STOL, and STOL/STOL aircraft and runway configurations are presented in tabular form and include probability of collision results obtained in the Lateral Separation Study for all cases cited in Figure B-1. Table B-1 is a guide to the probability of collision tables contained in this appendix. Zero values shown in the tables for each particular case denote probability of collision values which were smaller than the computational errors associated with a digital computer.



NOTE: The notation used above is X/Y

X — Runway 2

Y — Runway 1

Figure B-1

Cases Considered in Probability of Collision Analysis

Table B-1 Guide to Probability of Collision Tables

Aircraft and Runway Configuration	Operation	Approach	Table	Comments
CTOL/CTOL	Independent	FC/FC	B-2	
		FC/VOR	B-3	
		FC/BC	B-4	
	Dependent	FC/FC	B-5	Longitudinal Spacing of Three NMi
			B-6	Longitudinal Spacing of Two NMi
			B-7	Longitudinal Spacing of One NMi
			B-8	Longitudinal Spacing of One-Fourth NMi
CTOL/STOL	Independent	FC/FC	B-9	No Threshold Displacement
			B-10	3000 foot Threshold Displacement
STOL/STOL	Independent	FC/FC	B-11	

Table B-2

CTOL/CTOL Probability of Collision Data for FC/FC Independent Operations

Runway Separation, feet	Range from Threshold, nmi.	Probability of Collision
1500	6	.68 10^{-2}
	4	.75 10^{-3}
	2	.50 10^{-5}
2000	6	.11 10^{-2}
	4	.54 10^{-4}
	2	.16 10^{-7}
2500	6	.17 10^{-3}
	4	.28 10^{-5}
	2	.38 10^{-10}
3000	6	.22 10^{-4}
	4	.95 10^{-7}
	2	.30 10^{-13}
3500	6	.23 10^{-5}
	4	.37 10^{-8}
	2	.13 10^{-16}
4300	6	.57 10^{-7}
	4	.65 10^{-11}
	2	.16 10^{-22}
5000	6	.17 10^{-8}
	4	.16 10^{-13}
	2	.20 10^{-28}

Table B-3

CTOL/CTOL Probability of Collision Data for FC/VOR Independent Operations

Runway Separation, feet	Range from Threshold, nmi.	Probability of Collision
1500	6	$.18 \quad 10^{-1}$
	4	$.29 \quad 10^{-2}$
	2	$.16 \quad 10^{-4}$
2000	6	$.49 \quad 10^{-2}$
	4	$.27 \quad 10^{-3}$
	2	$.82 \quad 10^{-7}$
2500	6	$.14 \quad 10^{-2}$
	4	$.39 \quad 10^{-4}$
	2	$.31 \quad 10^{-9}$
3000	6	$.38 \quad 10^{-3}$
	4	$.35 \quad 10^{-5}$
	2	$.66 \quad 10^{-12}$
3500	6	$.67 \quad 10^{-4}$
	4	$.14 \quad 10^{-6}$
	2	$.92 \quad 10^{-15}$
4300	6	$.23 \quad 10^{-5}$
	4	$.14 \quad 10^{-8}$
	2	$.90 \quad 10^{-20}$
5000	6	$.12 \quad 10^{-6}$
	4	$.98 \quad 10^{-11}$
	2	$.12 \quad 10^{-24}$

Table B-4

CTOL/CTOL Probability of Collision Data for FC/BC Independent Operations

Runway Separation, feet	Range from Threshold, nmi.	Probability of Collision
1500	5	$.17 \quad 10^{-1}$
	4	$.61 \quad 10^{-2}$
	2	$.38 \quad 10^{-5}$
2000	5	$.45 \quad 10^{-2}$
	4	$.52 \quad 10^{-3}$
	2	$.11 \quad 10^{-7}$
2500	5	$.13 \quad 10^{-2}$
	4	$.97 \quad 10^{-4}$
	2	$.15 \quad 10^{-10}$
3000	5	$.36 \quad 10^{-3}$
	4	$.29 \quad 10^{-4}$
	2	$.63 \quad 10^{-14}$
3500	5	$.57 \quad 10^{-4}$
	4	$.28 \quad 10^{-5}$
	2	$.15 \quad 10^{-17}$
4300	5	$.10 \quad 10^{-5}$
	4	$.16 \quad 10^{-7}$
	2	$.55 \quad 10^{-24}$
5000	5	$.28 \quad 10^{-7}$
	4	$.40 \quad 10^{-9}$
	2	$.28 \quad 10^{-30}$

Table B-5

CTOL/CTOL Probability of Collision Data for FC/FC Dependent Operations and Longitudinal Spacing of Three Miles

Runway Separation, feet	Range from Threshold, nmi.	Probability of Collision
1500	3	10^{-71}
	2	10^{-51}
	1	10^{-39}
2000	3	10^{-72}
	2	10^{-52}
	1	10^{-40}
2500	3	10^{-73}
	2	10^{-53}
	1	10^{-42}
3000	3	10^{-74}
	2	10^{-55}
	1	10^{-44}
3500	3	10^{-76}
	2	10^{-56}
	1	10^{-46}
4300	3	10^{-78}
	2	10^{-60}
	1	10^{-53}
5000	3	10^{-81}
	2	10^{-64}
	1	10^{-63}

Table B-6

CTOL/CTOL Probability of Collision Data for FC/FC Dependent Operations and Longitudinal Spacing of Two Miles

Runway Separation, feet	Range from Threshold, nmi.	Probability of Collision
1500	4	10^{-43}
	3	10^{-29}
	2	10^{-22}
	1	10^{-19}
2000	4	10^{-44}
	3	10^{-31}
	2	10^{-24}
	1	10^{-21}
2500	4	10^{-44}
	3	10^{-32}
	2	10^{-26}
	1	10^{-24}
3000	4	10^{-46}
	3	10^{-33}
	2	10^{-28}
	1	10^{-26}
3500	4	10^{-47}
	3	10^{-35}
	2	10^{-30}
	1	10^{-29}
4300	4	10^{-49}
	3	10^{-38}
	2	10^{-33}
	1	10^{-36}

Table B-6 CTOL/CTOL Probability of Collision Data for FC/FC Dependent Operations and Longitudinal Spacing of Two Miles (Continued)

Runway Separation, feet	Range from Threshold, nmi.	Probability of Collision
5000	4	10^{-51}
	3	10^{-41}
	2	10^{-38}
	1	10^{-46}

Table B-7

CTOL/CTOL Probability of Collision Data for FC/FC Dependent Operations and Longitudinal Spacing of One Mile

Runway Separation, feet	Range from Threshold, nmi.	Probability of Collision
1500	5	10^{-16}
	4	10^{-11}
	3	10^{-9}
	2	10^{-9}
	1	10^{-10}
2000	5	10^{-17}
	4	10^{-12}
	3	10^{-11}
	2	10^{-11}
	1	10^{-13}
2500	5	10^{-18}
	4	10^{-13}
	3	10^{-12}
	2	10^{-13}
	1	10^{-17}
3000	5	10^{-19}
	4	10^{-15}
	3	10^{-14}
	2	10^{-16}
	1	10^{-21}
3500	5	10^{-20}
	4	10^{-16}

Table B-7 CTOL/CTOL Probability of Collision Data for FC/FC Dependent Operations and Longitudinal Spacing of One Mile (Continued)

Runway Separation, feet	Range from Threshold, nmi.	Probability of Collision
3500	3	10^{-16}
	2	10^{-18}
	1	10^{-25}
4300	5	10^{-22}
	4	10^{-18}
	3	10^{-19}
	2	10^{-23}
	1	10^{-35}
5000	5	10^{-23}
	4	10^{-21}
	3	10^{-22}
	2	10^{-27}
	1	$<10^{-120}$

Table B-8

CTOL/CTOL Probability of Collision Data for FC/FC Dependent Operations and Longitudinal Spacing of .25 Miles

Runway Separation, feet	Range from Threshold, nmi.	Probability of Collision
1500	5	$.14 \; 10^{-3}$
	4	$.53 \; 10^{-4}$
	3	$.76 \; 10^{-5}$
	2	$.46 \; 10^{-6}$
	1	$.68 \; 10^{-10}$
2000	5	$.17 \; 10^{-4}$
	4	$.41 \; 10^{-5}$
	3	$.28 \; 10^{-6}$
	2	$.16 \; 10^{-8}$
	1	$.17 \; 10^{-14}$
2500	5	$.17 \; 10^{-5}$
	4	$.23 \; 10^{-6}$
	3	$.28 \; 10^{-8}$
	2	$.57 \; 10^{-11}$
	1	$.11 \; 10^{-19}$
3000	5	$.13 \; 10^{-6}$
	4	$.87 \; 10^{-8}$
	3	$.84 \; 10^{-10}$
	2	$.60 \; 10^{-14}$
	1	$.75 \; 10^{-26}$

Table B-8 CTOL/CTOL Probability of Collision Data for FC/FC Dependent Operations and Longitudinal Spacing of .25 Miles (Continued)

Runway Separation feet	Range from Threshold, nmi.	Probability of Collision
3500	5	$.90\ 10^{-8}$
	4	$.38\ 10^{-9}$
	3	$.70\ 10^{-12}$
	2	$.40\ 10^{-17}$
	1	$.14\ 10^{-33}$
4300	5	$.10\ 10^{-9}$
	4	$.12\ 10^{-11}$
	3	$.10\ 10^{-15}$
	2	$.10\ 10^{-22}$
	1	$<10^{-120}$
5000	5	$.12\ 10^{-11}$
	4	$.31\ 10^{-14}$
	3	$.22\ 10^{-19}$
	2	$.29\ 10^{-28}$
	1	$<10^{-120}$

Table B-9

CTOL/STOL Probability of Collision Data for FC/FC Independent Operations and No Threshold Displacement

Runway Separation, feet	Range from Threshold, feet	Probability of Collision
1500	12200	10^{-23}
	9200	10^{-14}
	4700	10^{-16}
2000	12200	10^{-26}
	9200	10^{-17}
	4700	10^{-23}
2500	12200	10^{-29}
	9200	10^{-21}
	4700	10^{-35}
3000	12200	10^{-32}
	9200	10^{-25}
	4700	10^{-40}
3500	12200	10^{-36}
	9200	10^{-30}
	4700	10^{-40}
4300	12200	10^{-42}
	9200	10^{-40}
	4700	10^{-40}
5000	12200	10^{-50}
	9200	10^{-45}
	4700	10^{-40}

Table B-10

CTOL/STOL Probability of Collision Data for FC/FC Independent Operations with Threshold Displacement of 3000 Feet

Runway Separation, feet	Range from Threshold, feet	Probability of Collision
1500	7700	10^{-12}
	6200	10^{-11}
	4700	10^{-12}
2000	7700	10^{-16}
	6200	10^{-16}
	4700	10^{-19}
2500	7700	10^{-21}
	6200	10^{-22}
	4700	10^{-26}
3000	7700	10^{-26}
	6200	10^{-30}
	4700	10^{-39}
3500	7700	10^{-33}
	6200	10^{-40}
	4700	10^{-39}
4300	7700	10^{-42}
	6200	10^{-40}
	4700	10^{-39}
5000	7700	10^{-42}
	6200	10^{-40}
	4700	10^{-39}

Table B-11

STOL/STOL Probability of Collision Data for FC/FC Independent Operations

Runway Separation, feet	Range from Threshold, feet	Probability of Collision
1500	12000	10^{-2}
	7000	10^{-9}
	1000	10^{-41}
2000	12000	10^{-5}
	7000	10^{-18}
	1000	10^{-73}
2500	12000	10^{-9}
	7000	10^{-28}
	1000	10^{-118}
3000	12000	10^{-13}
	7000	10^{-41}
	1000	$<10^{-120}$
3500	12000	10^{-17}
	7000	10^{-57}
	1000	$<10^{-120}$
4300	12000	10^{-26}
	7000	10^{-88}
	1000	$<10^{-120}$
5000	12000	10^{-36}
	7000	10^{-120}
	1000	$<10^{-120}$

APPENDIX C

SINGLE AIRCRAFT BLUNDER ANALYSIS DATA

This appendix contains the output data for the single aircraft blunder analysis performed in the Lateral Separation study. The purpose of this analysis is to evaluate the cross-track distance (blunder recovery airspace) required for an aircraft to recover from the type 1 and type 2 blunders. Type 1 blunders occur when an aircraft that is on a track which intercepts the approach course at 10°, 20°, or 30° passes through the normal operating zone and proceeds toward the adjacent track. Type 2 blunders occur when an aircraft which is established on the final approach course (within the normal operating zone) makes a turn toward the adjacent course at 15°, 30°, or 45°. The blunder recovery maneuver is assumed to be a coordinated turn in the glideslope plane performed by the blundering aircraft. The geometry of the single aircraft analysis is shown in Figure C-1.

The single aircraft analysis utilized combinations of the blunder parameter values listed in Table C-1 excluding the data acquisition system (DAS) accuracies (ε_R and ε_A). The lateral recovery airspace required for parameter combinations for the single aircraft blunder analysis is presented in tabular form in Table C-2. Values for DAS errors (EDAS) should be added to these data when the position of the DAS antenna with respect to the blundered aircraft is known.

EDAS is evaluated using the following equations:

$$EDAS = E_A \cos\rho + \sin\rho$$

where,

$$E_A = R \tan \varepsilon_A$$

$$E_R = \frac{\varepsilon_R R}{100}$$

$$R = \sqrt{(X_{DAS} - X_{A/C})^2 + (Y_{DAS} - Y_{A/C})^2 + (Z_{DAS} - Z_{A/C})^2}$$

$$\rho = \tan^{-1} \left| \frac{Y_{DAS} - Y_{A/C}}{X_{DAS} - X_{A/C}} \right|$$

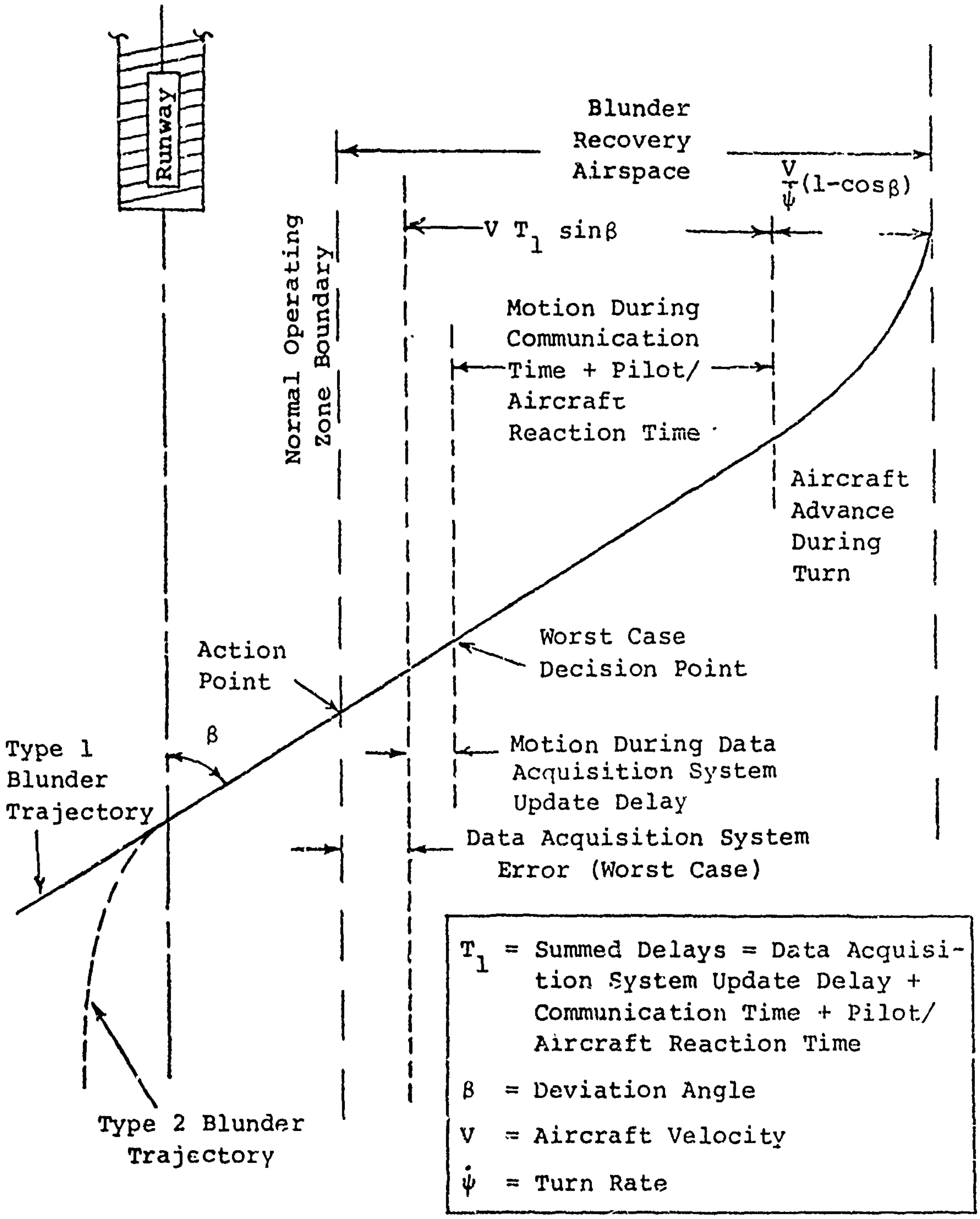


Figure C-1

Single Aircraft Geometric Analysis of the Two Types of Blunders

Table C-1 Blundered Aircraft Parameter Values

Parameters	Values	Units
Departure Angles		
Type 1 Blunder	10, 20, and 30	degrees
Type 2 Blunder	15, 30, and 45	degrees
DAS Range Accuracy (ε_R)	1.5, 1.0, .5, and .2	percentages of range
DAS Azimuth Accuracy (ε_A)	1.5, 1.0, and .5	degrees
DAS Update Delays	4, 2, 1, .5, .1, and .01	seconds
Aircraft Velocities	60, 80, 100, 120, 140, and 160	knots
Aircraft Bank Angles	10, 20, 30, and 40	degrees
Pilot/Aircraft Reaction Times	1.5, 5, and 8	seconds
Communication Times	1 to 10	seconds

with,

$X_{A/C}$ - Aircraft ground range to touchdown, ft.

$Y_{A/C}$ - Aircraft lateral location from the runway centerline, ft.

$Z_{A/C}$ - Aircraft altitude, ft.

X_{DAS} - DAS antenna ground range from touchdown, ft.

Y_{DAS} - DAS antenna lateral location from the runway centerline, ft.

Z_{DAS} - DAS antenna altitude, ft.

The above equations were derived by using the geometry illustrated in Figure C-2.

The column headings for Table C-2 are explained as follows:

Departure Angle (deg.) - the angle at which a blundered aircraft heads toward the adjacent approach course measured from the extended runway centerline.

Velocity (knots) - the velocity of the blundered aircraft.

Bank Angle (deg.) - the bank angle that the blundered aircraft uses to make the corrective maneuver.

Summed Delays (sec.) - a total of all the delays of the blundered aircraft, including DAS Update Delay, Communication Time, and Pilot/Aircraft Reaction Time.

Blunder Recovery Airspace (ft.) - the lateral recovery airspace, excluding EDAS, required for a blundered aircraft to recover from the type 1 or type 2 blunders, measured from the action point and perpendicular to the extended runway centerline.

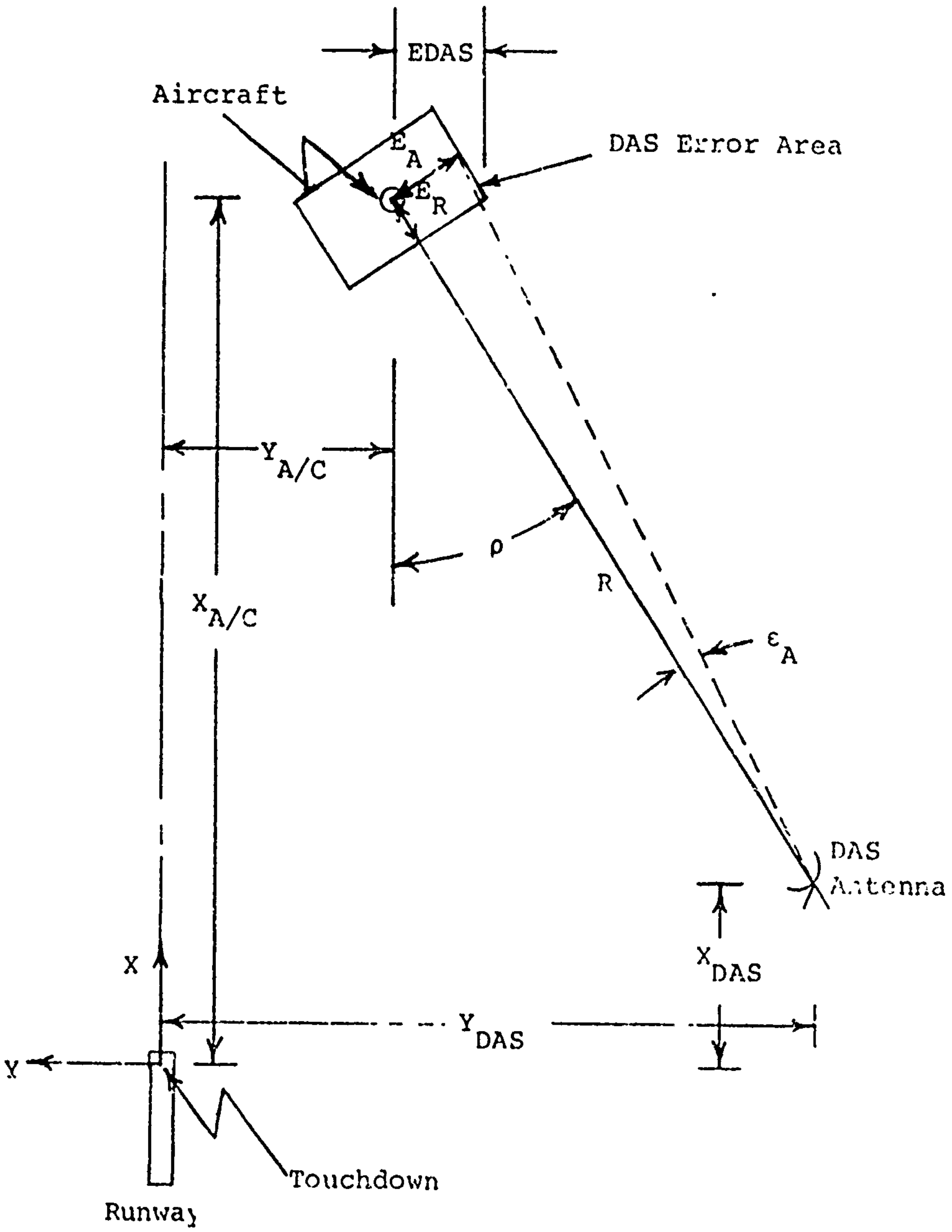


Figure C-2 DAS Configuration

Table C-2

Single Aircraft Blunder Analysis Output

********** BLUNDER ANALYSIS ********** PAGE = 1

DEPARTURE ANGLE (DEG.)	VELOCITY (KNOTS)	BANK ANGLE (DEG.)	SUMMED DELAYS (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
10.00	60.00	40.00	2.50	49.73
10.00	60.00	40.00	9.00	164.03
10.00	60.00	40.00	16.00	287.13
10.00	60.00	40.00	22.00	392.64
10.00	60.00	30.00	2.50	52.34
10.00	60.00	30.00	9.00	166.65
10.00	60.00	30.00	16.00	289.74
10.00	60.00	30.00	22.00	395.25
10.00	60.00	20.00	2.50	57.26
10.00	60.00	20.00	9.00	171.56
10.00	60.00	20.00	16.00	294.65
10.00	60.00	[illegible]	22.00	400.16
10.00	60.00	[illegible]	2.50	71.40
10.00	60.00	[illegible]	9.00	185.71
10.00	60.00	10.00	16.00	306.80
10.00	60.00	10.00	22.00	414.31
10.00	80.00	40.00	2.50	68.87
10.00	80.00	40.00	9.00	221.27
10.00	80.00	40.00	16.00	385.40
10.00	80.00	40.00	22.00	526.08
10.00	80.00	30.00	2.50	73.52
10.00	80.00	30.00	9.00	225.92
10.00	80.00	30.00	16.00	390.05
10.00	80.00	30.00	22.00	530.73
10.00	80.00	20.00	2.50	82.25
10.00	80.00	20.00	9.00	234.65
10.00	80.00	20.00	16.00	398.78
10.00	80.00	20.00	22.00	539.46
10.00	80.00	10.00	2.50	107.40
10.00	80.00	10.00	9.00	259.80
10.00	80.00	10.00	16.00	423.93
10.00	80.00	10.00	22.00	564.61

********** BLUNDER ANALYSIS *********

DEPARTURE ANGLE (DEG.)	VELOCITY (KNOTS)	BANK ANGLE (DEG.)	SUMMED DELAYS (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
10.00	100.00	40.00	2.50	89.29
10.00	100.00	40.00	9.00	279.79
10.00	100.00	40.00	16.00	484.95
10.00	100.00	40.00	22.00	660.80
10.00	100.00	30.00	2.50	96.55
10.00	100.00	30.00	9.00	287.66
10.00	100.00	30.00	16.00	492.21
10.00	100.00	30.00	22.00	666.06
10.00	100.00	20.00	2.50	110.20
10.00	100.00	20.00	9.00	300.70
10.00	100.00	20.00	16.00	505.86
10.00	100.00	20.00	22.00	681.71
10.00	100.00	10.00	2.50	149.50
10.00	100.00	10.00	9.00	340.00
10.00	100.00	10.00	16.00	545.16
10.00	100.00	10.00	22.00	721.01
10.00	120.00	40.00	2.50	110.99
10.00	120.00	40.00	9.00	339.60
10.00	120.00	40.00	16.00	585.79
10.00	120.00	40.00	22.00	796.81
10.00	120.00	30.00	2.50	121.45
10.00	120.00	30.00	9.00	350.05
10.00	120.00	30.00	16.00	596.24
10.00	120.00	30.00	22.00	807.26
10.00	120.00	20.00	2.50	141.10
10.00	120.00	20.00	9.00	369.71
10.00	120.00	20.00	16.00	615.90
10.00	120.00	20.00	22.00	826.92
10.00	120.00	10.00	2.50	197.69
10.00	120.00	10.00	9.00	426.29
10.00	120.00	10.00	16.00	672.48
10.00	120.00	10.00	22.00	853.50

********** HEL MODEL ANALYSIS *********

DEPARTURE ANGLE(DEG.)	VELOCITY (KNOTS)	BANK ANGLE(DEG.)	SYSTEM DELAYS(SEC.)	LUNDER RECOVERY AIRSPACE(FT.)
10.00	140.00	40.00	2.50	133.97
10.00	140.00	40.00	9.00	400.68
10.00	140.00	40.00	16.00	667.90
10.00	140.00	40.00	22.00	934.09
10.00	140.00	30.00	2.50	148.21
10.00	140.00	30.00	9.00	414.91
10.00	140.00	30.00	16.00	702.14
10.00	140.00	30.00	22.00	948.33
10.00	140.00	20.00	2.50	174.96
10.00	140.00	20.00	9.00	441.66
10.00	140.00	20.00	16.00	728.89
10.00	140.00	20.00	22.00	975.06
10.00	140.00	10.00	2.50	251.98
10.00	140.00	10.00	9.00	518.69
10.00	140.00	10.00	16.00	805.91
10.00	140.00	10.00	22.00	1052.10
10.00	160.00	40.00	2.50	158.24
10.00	160.00	40.00	9.00	463.05
10.00	160.00	40.00	16.00	791.30
10.00	160.00	40.00	22.00	1072.66
10.00	160.00	30.00	2.50	176.83
10.00	160.00	30.00	9.00	481.64
10.00	160.00	30.00	16.00	809.89
10.00	160.00	30.00	22.00	1091.25
10.00	160.00	20.00	2.50	211.77
10.00	160.00	20.00	9.00	516.57
10.00	160.00	20.00	16.00	844.83
10.00	160.00	20.00	22.00	1126.19
10.00	160.00	10.00	2.50	312.37
10.00	160.00	10.00	9.00	617.17
10.00	160.00	10.00	16.00	945.43
10.00	160.00	10.00	22.00	1226.79

********** [illegible] ANALYSIS *********

[illegible] ANGLE (DEG.)	VELOCITY (KNOTS)	[illegible] ANGLE (DEG.)	SUMMED DELAYS (SEC.)	[illegible] RECOVERY AIRSPACE (FT.)
15.00	60.00	40.00	2.50	78.40
15.00	60.00	40.00	9.00	248.82
15.00	60.00	40.00	16.00	432.30
15.00	60.00	40.00	22.00	589.56
15.00	60.00	30.00	2.50	84.32
15.00	60.00	30.00	9.00	254.69
15.00	60.00	30.00	16.00	438.16
15.00	60.00	30.00	22.00	595.42
15.00	60.00	20.00	2.50	95.34
15.00	60.00	20.00	9.00	265.71
15.00	60.00	20.00	16.00	449.18
15.00	60.00	20.00	22.00	606.44
15.00	60.00	10.00	2.50	127.07
15.00	60.00	10.00	9.00	297.44
15.00	60.00	10.00	16.00	480.91
15.00	60.00	10.00	22.00	638.17
15.00	80.00	40.00	2.50	110.36
15.00	80.00	40.00	9.00	337.51
15.00	80.00	40.00	16.00	582.14
15.00	80.00	40.00	22.00	791.82
15.00	80.00	30.00	2.50	120.78
15.00	80.00	30.00	9.00	347.94
15.00	80.00	30.00	16.00	592.57
15.00	80.00	30.00	22.00	802.25
15.00	80.00	20.00	2.50	140.37
15.00	80.00	20.00	9.00	367.53
15.00	80.00	20.00	16.00	612.16
15.00	80.00	20.00	22.00	821.84
15.00	80.00	10.00	2.50	196.78
15.00	80.00	10.00	9.00	423.94
15.00	80.00	10.00	16.00	668.56
15.00	80.00	10.00	22.00	878.25

DEPARTURE ANGLE(DEG.)	VELOCITY (KNOTS)	BANK ANGLE(DEG.)	SUMMED DELAYS(SEC.)	BLUNDER RECOVERY AIRSPACE(FT.)
15.00	100.00	40.00	2.50	145.13
15.00	100.00	40.00	9.00	429.08
15.00	100.00	40.00	16.00	734.86
15.00	100.00	40.00	22.00	996.96
15.00	100.00	30.00	2.50	161.42
15.00	100.00	30.00	9.00	445.36
15.00	100.00	30.00	16.00	751.15
15.00	100.00	30.00	22.00	1013.25
15.00	100.00	20.00	2.50	192.03
15.00	100.00	20.00	9.00	475.97
15.00	100.00	20.00	16.00	761.76
15.00	100.00	20.00	22.00	1043.86
15.00	100.00	10.00	2.50	280.17
15.00	100.00	10.00	9.00	564.11
15.00	100.00	10.00	16.00	869.90
15.00	100.00	10.00	22.00	1132.00
15.00	120.00	40.00	2.50	182.78
15.00	120.00	40.00	9.00	523.52
15.00	120.00	40.00	16.00	890.46
15.00	120.00	40.00	22.00	1204.98
15.00	120.00	30.00	2.50	206.24
15.00	120.00	30.00	9.00	546.97
15.00	120.00	30.00	16.00	913.91
15.00	120.00	30.00	22.00	1228.43
15.00	120.00	20.00	2.50	250.32
15.00	120.00	20.00	9.00	591.05
15.00	120.00	20.00	16.00	957.99
15.00	120.00	20.00	22.00	1272.51
15.00	120.00	10.00	2.50	377.23
15.00	120.00	10.00	9.00	717.97
15.00	120.00	10.00	16.00	1084.91
15.00	120.00	10.00	22.00	1399.43

DEPARTURE ANGLE(DEG.)	VELOCITY (KNOTS)	TRACK ANGLE(DEG.)	SUMMED DELAYS(SEC.)	BLUNDER RECOVERY AIRSPACE(FT.)
15.00	140.00	40.00	2.50	223.31
15.00	140.00	40.00	9.00	620.83
15.00	140.00	40.00	16.00	1048.93
15.00	140.00	40.00	22.00	1415.87
15.00	140.00	30.00	2.50	255.23
15.00	140.00	30.00	9.00	652.75
15.00	140.00	30.00	16.00	1080.85
15.00	140.00	30.00	22.00	1447.79
15.00	140.00	20.00	2.50	315.22
15.00	140.00	20.00	9.00	712.75
15.00	140.00	20.00	16.00	1140.84
15.00	140.00	20.00	22.00	1507.79
15.00	140.00	10.00	2.50	467.98
15.00	140.00	10.00	9.00	865.50
15.00	140.00	10.00	16.00	1313.59
15.00	140.00	10.00	22.00	1680.54
15.00	160.00	40.00	2.50	266.70
15.00	160.00	40.00	9.00	721.01
15.00	160.00	40.00	16.00	1210.27
15.00	160.00	40.00	22.00	1629.63
15.00	160.00	30.00	2.50	308.40
15.00	160.00	30.00	9.00	762.71
15.00	160.00	30.00	16.00	1251.96
15.00	160.00	30.00	22.00	1671.33
15.00	160.00	20.00	2.50	356.76
15.00	160.00	20.00	9.00	841.07
15.00	160.00	20.00	16.00	1330.33
15.00	160.00	20.00	22.00	1749.69
15.00	160.00	10.00	2.50	612.39
15.00	160.00	10.00	9.00	1066.70
15.00	160.00	10.00	16.00	1555.96
15.00	160.00	10.00	22.00	1975.32

********** BLUNDER ANALYSIS *********

DEPARTURE ANGLE(DEG.)	VELOCITY (KNOTS)	BANK ANGLE(DEG.)	SUMMED DELAYS(SEC.)	BLUNDER RECOVERY AIRSPACE(FT.)
20.00	60.00	40.00	2.50	109.48
20.00	60.00	40.00	9.00	334.61
20.00	60.00	40.00	16.00	577.06
20.00	60.00	40.00	22.00	784.88
20.00	60.00	30.00	2.50	119.86
20.00	60.00	30.00	9.00	344.99
20.00	60.00	30.00	16.00	587.44
20.00	60.00	30.00	22.00	795.25
20.00	60.00	20.00	2.50	139.36
20.00	60.00	20.00	9.00	364.49
20.00	60.00	20.00	16.00	606.94
20.00	60.00	20.00	22.00	814.76
20.00	60.00	10.00	2.50	195.52
20.00	60.00	10.00	9.00	420.65
20.00	60.00	10.00	16.00	663.10
20.00	60.00	10.00	22.00	870.92
20.00	80.00	40.00	2.50	156.15
20.00	80.00	40.00	9.00	456.32
20.00	80.00	40.00	16.00	779.59
20.00	80.00	40.00	22.00	1056.68
20.00	80.00	30.00	2.50	174.60
20.00	80.00	30.00	9.00	474.77
20.00	80.00	30.00	16.00	798.04
20.00	80.00	30.00	22.00	1075.13
20.00	80.00	20.00	2.50	209.27
20.00	80.00	20.00	9.00	509.44
20.00	80.00	20.00	16.00	832.71
20.00	80.00	20.00	22.00	1109.80
20.00	80.00	10.00	2.50	309.10
20.00	80.00	10.00	9.00	609.28
20.00	80.00	10.00	16.00	932.55
20.00	80.00	10.00	22.00	1209.63

********** BLUNDER ANALYSIS ********* PAGE = 8

DEPARTURE ANGLE(DEG.)	VELOCITY (KNOTS)	BANK ANGLE(DEG.)	SUMMED DELAYS(SEC.)	BLUNDER RECOVERY AIRSPACE(FT.)
20.00	100.00	40.00	2.50	207.90
20.00	100.00	40.00	9.00	583.12
20.00	100.00	40.00	16.00	987.20
20.00	100.00	40.00	22.00	1333.56
20.00	100.00	30.00	2.50	236.73
20.00	100.00	30.00	9.00	611.95
20.00	100.00	30.00	16.00	1016.03
20.00	100.00	30.00	22.00	1362.39
20.00	100.00	20.00	2.50	290.90
20.00	100.00	20.00	9.00	666.12
20.00	100.00	20.00	16.00	1070.21
20.00	100.00	20.00	22.00	1416.56
20.00	100.00	10.00	2.50	446.90
20.00	100.00	10.00	9.00	822.12
20.00	100.00	10.00	16.00	1226.20
20.00	100.00	10.00	22.00	1572.56
20.00	120.00	40.00	2.50	264.74
20.00	120.00	40.00	9.00	715.00
20.00	120.00	40.00	16.00	1199.91
20.00	120.00	40.00	22.00	1615.53
20.00	120.00	30.00	2.50	306.25
20.00	120.00	30.00	9.00	756.51
20.00	120.00	30.00	16.00	1241.42
20.00	120.00	30.00	22.00	1657.04
20.00	120.00	20.00	2.50	384.26
20.00	120.00	20.00	9.00	834.53
20.00	120.00	20.00	16.00	1319.43
20.00	120.00	20.00	22.00	1735.06
20.00	120.00	10.00	2.50	608.90
20.00	120.00	10.00	9.00	1059.16
20.00	120.00	10.00	16.00	1544.06
20.00	120.00	10.00	22.00	1959.69

********** BLUNDER ANALYSIS ********** PAGE = 9

DEPARTURE ANGLE(DEG.)	VELOCITY (KNOTS)	TRACK ANGLE(DEG.)	SUMMED DELAYS(SEC.)	BLUNDER RECOVERY AIRSPACE(FT.)
20.00	140.00	40.00	2.50	326.67
20.00	140.00	40.00	9.00	851.98
20.00	140.00	40.00	16.00	1417.69
20.00	140.00	40.00	22.00	1902.59
20.00	140.00	30.00	2.50	383.17
20.00	140.00	30.00	9.00	908.48
20.00	140.00	30.00	16.00	1474.19
20.00	140.00	30.00	22.00	1959.09
20.00	140.00	20.00	2.50	469.35
20.00	140.00	20.00	9.00	1014.66
20.00	140.00	20.00	16.00	1580.38
20.00	140.00	20.00	22.00	2065.28
20.00	140.00	10.00	2.50	795.10
20.00	140.00	10.00	9.00	1320.41
20.00	140.00	10.00	16.00	1886.13
20.00	140.00	10.00	22.00	2371.03
20.00	160.00	40.00	2.50	393.68
20.00	160.00	40.00	9.00	994.03
20.00	160.00	40.00	16.00	1640.57
20.00	160.00	40.00	22.00	2194.74
20.00	160.00	30.00	2.50	467.48
20.00	160.00	30.00	9.00	1067.83
20.00	160.00	30.00	16.00	1714.36
20.00	160.00	30.00	22.00	2268.54
20.00	160.00	20.00	2.50	606.17
20.00	160.00	20.00	9.00	1206.52
20.00	160.00	20.00	16.00	1853.05
20.00	160.00	20.00	22.00	2407.23
20.00	160.00	10.00	2.50	1005.51
20.00	160.00	10.00	9.00	1605.86
20.00	160.00	10.00	16.00	2252.40
20.00	160.00	10.00	22.00	2806.57

********** BLUNDER ANALYSIS **********

DEPARTURE ANGLE(DEG.)	VELOCITY (KNOTS)	BANK ANGLE(DEG.)	SUMMED DELAYS(SEC.)	BLUNDER RECOVERY AIRSPACE(FT.)
30.00	60.00	40.00	2.50	177.44
30.00	60.00	40.00	9.00	506.56
30.00	60.00	40.00	16.00	861.00
30.00	60.00	40.00	22.00	1164.80
30.00	60.00	30.00	2.50	200.49
30.00	60.00	30.00	9.00	529.61
30.00	60.00	30.00	16.00	884.05
30.00	60.00	30.00	22.00	1187.86
30.00	60.00	20.00	2.50	243.82
30.00	60.00	20.00	9.00	572.94
30.00	60.00	20.00	16.00	927.38
30.00	60.00	20.00	22.00	1231.18
30.00	60.00	10.00	2.50	368.57
30.00	60.00	10.00	9.00	697.70
30.00	60.00	10.00	16.00	1052.13
30.00	60.00	10.00	22.00	1355.94
30.00	80.00	40.00	2.50	259.18
30.00	80.00	40.00	9.00	698.01
30.00	80.00	40.00	16.00	1170.60
30.00	80.00	40.00	22.00	1575.67
30.00	80.00	30.00	2.50	300.17
30.00	80.00	30.00	9.00	739.00
30.00	80.00	30.00	16.00	1211.58
30.00	80.00	30.00	22.00	1613.65
30.00	80.00	20.00	2.50	377.19
30.00	80.00	20.00	9.00	816.02
30.00	80.00	20.00	16.00	1288.61
30.00	80.00	20.00	22.00	1693.68
30.00	80.00	10.00	2.50	598.98
30.00	80.00	10.00	9.00	1037.81
30.00	80.00	10.00	16.00	1510.40
30.00	80.00	10.00	22.00	1915.47

********** BLUNDER ANALYSIS *********

DEPARTURE ANGLE(DEG.)	VELOCITY (KNOTS)	BANK ANGLE(DEG.)	SUMMED DELAYS(SEC.)	BLUNDER RECOVERY AIRSPACE(FT.)
30.00	100.00	40.00	2.50	352.23
30.00	100.00	40.00	9.00	900.77
30.00	100.00	40.00	16.00	1491.50
30.00	100.00	40.00	22.00	1997.84
30.00	100.00	30.00	2.50	416.27
30.00	100.00	30.00	9.00	964.80
30.00	100.00	30.00	16.00	1555.54
30.00	100.00	30.00	22.00	2061.88
30.00	100.00	20.00	2.50	536.62
30.00	100.00	20.00	9.00	1085.16
30.00	100.00	20.00	16.00	1675.89
30.00	100.00	20.00	22.00	2182.23
30.00	100.00	10.00	2.50	883.17
30.00	100.00	10.00	9.00	1431.70
30.00	100.00	10.00	16.00	2022.43
30.00	100.00	10.00	22.00	2528.78
30.00	120.00	40.00	2.50	456.58
30.00	120.00	40.00	9.00	1114.82
30.00	120.00	40.00	16.00	1823.70
30.00	120.00	40.00	22.00	2431.31
30.00	120.00	30.00	2.50	548.79
30.00	120.00	30.00	9.00	1207.04
30.00	120.00	30.00	16.00	1915.91
30.00	120.00	30.00	22.00	2523.52
30.00	120.00	20.00	2.50	722.10
30.00	120.00	20.00	9.00	1380.34
30.00	120.00	20.00	16.00	2089.22
30.00	120.00	20.00	22.00	2696.83
30.00	120.00	10.00	2.50	1221.13
30.00	120.00	10.00	9.00	1879.37
30.00	120.00	10.00	16.00	2538.25
30.00	120.00	10.00	22.00	3195.66

********** BLUNDER ANALYSIS **********

DEPARTURE ANGLE(DEG.)	VELOCITY (KNOTS)	BANK ANGLE(DEG.)	SUMMED DELAYS(SEC.)	BLUNDER RECOVERY AIRSPACE(FT.)
30.00	140.00	40.00	2.50	572.22
30.00	140.00	40.00	9.00	1340.17
30.00	140.00	40.00	16.00	2167.20
30.00	140.00	40.00	22.00	2876.07
30.00	140.00	30.00	2.50	697.74
30.00	140.00	30.00	9.00	1465.69
30.00	140.00	30.00	16.00	2292.71
30.00	140.00	30.00	22.00	3001.59
30.00	140.00	20.00	2.50	933.63
30.00	140.00	20.00	9.00	1701.58
30.00	140.00	20.00	16.00	2528.61
30.00	140.00	20.00	22.00	3237.48
30.00	140.00	10.00	2.50	1612.86
30.00	140.00	10.00	9.00	2380.81
30.00	140.00	10.00	16.00	3207.84
30.00	140.00	10.00	22.00	3916.71
30.00	160.00	40.00	2.50	699.17
30.00	160.00	40.00	9.00	1576.83
30.00	160.00	40.00	16.00	2522.00
30.00	160.00	40.00	22.00	3332.14
30.00	160.00	30.00	2.50	863.11
30.00	160.00	30.00	9.00	1740.77
30.00	160.00	30.00	16.00	2685.94
30.00	160.00	30.00	22.00	3496.08
30.00	160.00	20.00	2.50	1171.22
30.00	160.00	20.00	9.00	2048.87
30.00	160.00	20.00	16.00	2994.04
30.00	160.00	20.00	22.00	3804.19
30.00	160.00	10.00	2.50	2058.37
30.00	160.00	10.00	9.00	2936.03
30.00	160.00	10.00	16.00	3881.20
30.00	160.00	10.00	22.00	4691.35

********** BLUNDER ANALYSIS *********

DEPARTURE ANGLE(DEG.)	VELOCITY (KNOTS)	BANK ANGLE(DEG.)	SUMMED DELAYS(SEC.)	BLUNDER RECOVERY AIRSPACE(FT.)
45.00	60.00	40.00	2.50	290.19
45.00	60.00	40.00	9.00	755.64
45.00	60.00	40.00	16.00	1256.89
45.00	60.00	40.00	22.00	1686.53
45.00	60.00	30.00	2.50	340.59
45.00	60.00	30.00	9.00	806.04
45.00	60.00	30.00	16.00	1307.29
45.00	60.00	30.00	22.00	1736.94
45.00	60.00	20.00	2.50	435.31
45.00	60.00	20.00	9.00	900.76
45.00	60.00	20.00	16.00	1402.01
45.00	60.00	20.00	22.00	1831.66
45.00	60.00	10.00	2.50	708.05
45.00	60.00	10.00	9.00	1173.50
45.00	60.00	10.00	16.00	1674.75
45.00	60.00	10.00	22.00	2104.40
45.00	80.00	40.00	2.50	436.33
.5.00	80.00	40.00	9.00	1056.93
45.00	80.00	40.00	16.00	1725.26
45.00	80.00	40.00	22.00	2298.12
45.00	80.00	30.00	2.50	525.93
45.00	80.00	30.00	9.00	1146.53
45.00	80.00	30.00	16.00	1814.86
45.00	80.00	30.00	22.00	2387.72
45.00	80.00	20.00	2.50	694.32
45.00	80.00	20.00	9.00	1314.92
45.00	80.00	20.00	16.00	1983.26
45.00	80.00	20.00	22.00	2556.12
45.00	80.00	10.00	2.50	1179.19
45.00	80.00	10.00	9.00	1799.79
45.00	80.00	10.00	16.00	2468.13
45.00	80.00	10.00	22.00	3040.99

********** BLUNDER ANALYSIS *********

DEPARTURE ANGLE(DEG.)	VELOCITY (KNOTS)	BANK ANGLE(DEG.)	SUMMED DELAYS(SEC.)	BLUNDER RECOVERY AIRSPACE(FT.)
45.00	100.00	40.00	2.50	607.17
45.00	100.00	40.00	9.00	1382.92
45.00	100.00	40.00	16.00	2218.34
45.00	100.00	40.00	22.00	2934.41
45.00	100.00	30.00	2.50	747.17
45.00	100.00	30.00	9.00	1522.92
45.00	100.00	30.00	16.00	2358.34
45.00	100.00	30.00	22.00	3074.42
45.00	100.00	20.00	2.50	1010.29
45.00	100.00	20.00	9.00	1786.04
45.00	100.00	20.00	16.00	2621.46
45.00	100.00	20.00	22.00	3337.53
45.00	100.00	10.00	2.50	1767.90
45.00	100.00	10.00	9.00	2543.65
45.00	100.00	10.00	16.00	3379.07
45.00	100.00	10.00	22.00	4095.14
45.00	120.00	40.00	2.50	802.72
45.00	120.00	40.00	9.00	1733.62
45.00	120.00	40.00	16.00	2736.12
45.00	120.00	40.00	22.00	3595.41
45.00	120.00	30.00	2.50	1004.32
45.00	120.00	30.00	9.00	1935.22
45.00	120.00	30.00	16.00	2937.72
45.00	120.00	30.00	22.00	3797.01
45.00	120.00	20.00	2.50	1383.21
45.00	120.00	20.00	9.00	2314.10
45.00	120.00	20.00	16.00	3316.61
45.00	120.00	20.00	22.00	4175.90
45.00	120.00	10.00	2.50	2474.17
45.00	120.00	10.00	9.00	3405.07
45.00	120.00	10.00	16.00	4407.57
45.00	120.00	10.00	22.00	5266.86

********** BLUNDER ANALYSIS *********

DEPARTURE ANGLE(DEG.)	VELOCITY (KNOTS)	BANK ANGLE(DEG.)	SUMMED DELAYS(SEC.)	BLUNDER RECOVERY AIRSPACE(FT.)
45.00	140.00	40.00	2.50	1022.97
45.00	140.00	40.00	9.00	2109.02
45.00	140.00	40.00	16.00	3278.61
45.00	140.00	40.00	22.00	4281.11
45.00	140.00	30.00	2.50	1297.37
45.00	140.00	30.00	9.00	2383.42
45.00	140.00	30.00	16.00	3553.01
45.00	140.00	30.00	22.00	4555.51
45.00	140.00	20.00	2.50	1813.08
45.00	140.00	20.00	9.00	2899.13
45.00	140.00	20.00	16.00	4068.72
45.00	140.00	20.00	22.00	5071.22
45.00	140.00	10.00	2.50	3298.00
45.00	140.00	10.00	9.00	4384.05
45.00	140.00	10.00	16.00	5553.64
45.00	140.00	10.00	22.00	6556.14
45.00	160.00	40.00	2.50	1267.93
45.00	160.00	40.00	9.00	2509.12
45.00	160.00	40.00	16.00	3845.80
45.00	160.00	40.00	22.00	4991.52
45.00	160.00	30.00	2.50	1626.33
45.00	160.00	30.00	9.00	2867.53
45.00	160.00	30.00	16.00	4204.20
45.00	160.00	30.00	22.00	5349.92
45.00	160.00	20.00	2.50	2299.91
45.00	160.00	20.00	9.00	3541.[illegible]0
45.00	160.00	20.00	16.00	4877.78
45.00	160.00	20.00	22.00	6023.50
45.00	160.00	10.00	2.50	4239.39
45.00	160.00	10.00	9.00	5480.59
45.00	160.00	10.00	16.00	6817.26
45.00	160.00	10.00	22.00	7962.98

APPENDIX D

DUAL AIRCRAFT BLUNDER ANALYSIS DATA

This appendix contains the output data for the dual aircraft blunder analysis performed in the Lateral Separation study. The purpose of the dual aircraft analysis is to evaluate the blunder recovery airspace required for a blundered aircraft to recover from the type 1 and type 2 blunders, assuming that the blundered aircraft does not immediately respond to controller warnings. Type 1 blunders occur when an aircraft that is on a track which intercepts the approach course at 10°, 20°, or 30° passes through the normal operating zone and proceeds toward the adjacent track. Type 2 blunders occur when an aircraft which is established on the final approach course (within the normal operating zone) makes a turn toward the adjacent course at 15°, 30°, or 45°. The failure of the aircraft to respond makes it necessary for the controller to command an avoidance maneuver for the adjacent aircraft approaching the adjacent runway. The recovery of the blundered aircraft is considered complete when the heading of the blundered aircraft is the same as the heading of the aircraft on the adjacent approach course, meaning that both aircraft are flying parallel courses at that instant. Therefore, this analysis technique not only requires maneuvering the blundered aircraft but also requires maneuvering the aircraft on the adjacent course. The recovery maneuvers are assumed to be coordinated turns in the glideslope plane. The dual aircraft blunder analysis is based upon the assumed sequence of events shown in Table D-1 and the geometry shown in Figure D-1.

The dual aircraft analysis was used to determine the lateral recovery airspace for all combinations of the parameter values in Table D-2, excluding the data acquisition system (DAS) accuracies (ε_R and ε_A), and the results are presented in tabular form in Table D-3. Values for DAS errors (EDAS) should be added to these data when the position of the DAS antenna and the blundered aircraft can be approximated.

EDAS is evaluated by using the following equations:

$$EDAS = E_A \cos\rho + \sin\rho$$

Table D-1

Dual Aircraft Blunder Analysis
Sequence of Delays

Blundered Aircraft	Adjacent Aircraft
(1) DAS update delay	
(2) Controller_1 communication time	
(3) Pilot_1 reaction time	
(4) Aircraft_1 response time	(4) Controller_1 to Controller_2 delay
(5) Aircraft_1 turn time	(5) Controller_2 communication time
	(6) Pilot_2 reaction time
	(7) Aircraft_2 response time
	(8) Aircraft_2 turn time

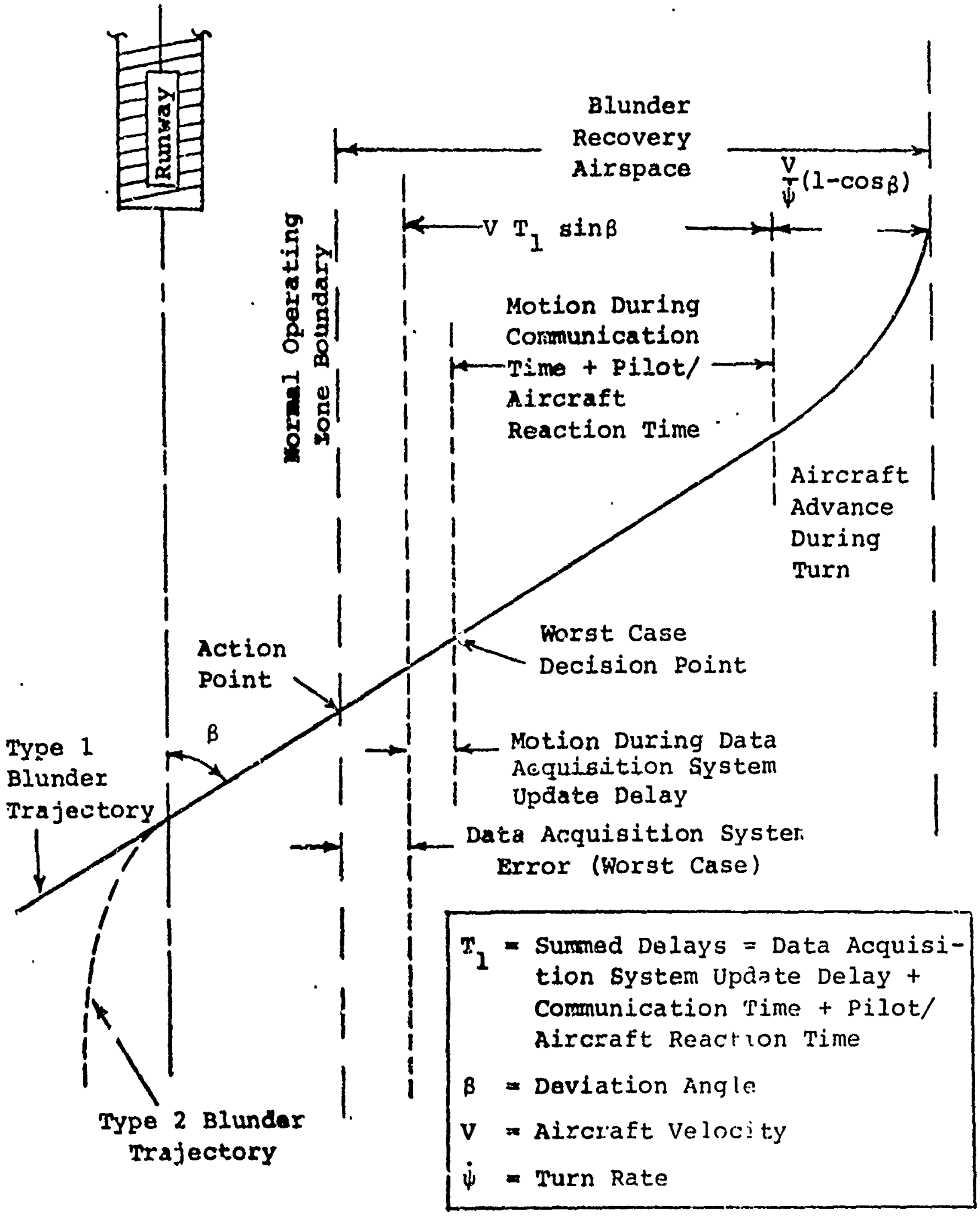


Figure D-1

Single Aircraft Geometric Analysis of the Two Types of Blunders

Table D-2 Blundered Aircraft Parameter Values

Parameters	Values	Units
Departure Angles		
Type 1 Blunder	10, 20, and 30	degrees
Type 2 Blunder	15, 30, and 45	degrees
DAS Range Accuracy (ε_R)	1.5, 1.0, .5, and .2	percentages of range
DAS Azimuth Accuracy (ε_A)	1.5, 1.0, and .5	degrees
DAS Update Delays	4, 2, 1, .5, .1, and .01	seconds
Aircraft Velocities	60, 80, 100, 120, 140, and 160	knots
Aircraft Bank Angles	10, 20, 30, and 40	degrees
Pilot/Aircraft Reaction Times	1.5, 5, and 8	seconds
Communication Times	1 to 10	seconds

where,

$$E_A = R \tan \epsilon_A$$

$$E_R = \frac{\epsilon_R R}{100}$$

$$R = \sqrt{(X_{DAS} - X_{A/C})^2 + (Y_{DAS} - Y_{A/C})^2 + (Z_{DAS} - Z_{A/C})^2}$$

$$\rho = \tan^{-1} \left| \frac{Y_{DAS} - Y_{A/C}}{X_{DAS} - X_{A/C}} \right|$$

with,

$X_{A/C}$ - Aircraft ground range to touchdown, ft.

$Y_{A/C}$ - Aircraft lateral location from the runway centerline, ft.

$Z_{A/C}$ - Aircraft altitude, ft.

X_{DAS} - DAS antenna ground range from touchdown, ft.

Y_{DAS} - DAS antenna lateral location from the runway centerline, ft.

Z_{DAS} - DAS antenna altitude, ft.

The above equations were derived by using the geometry illustrated in Figure D-2.

The column headings for Table D-3 are explained as follows:

Blundered Departure Angle (deg.) - the angle at which a blundered aircraft heads toward the adjacent approach course measured from the extended runway centerline.

Blundered Velocity (knots) - the velocity of the blundered aircraft.

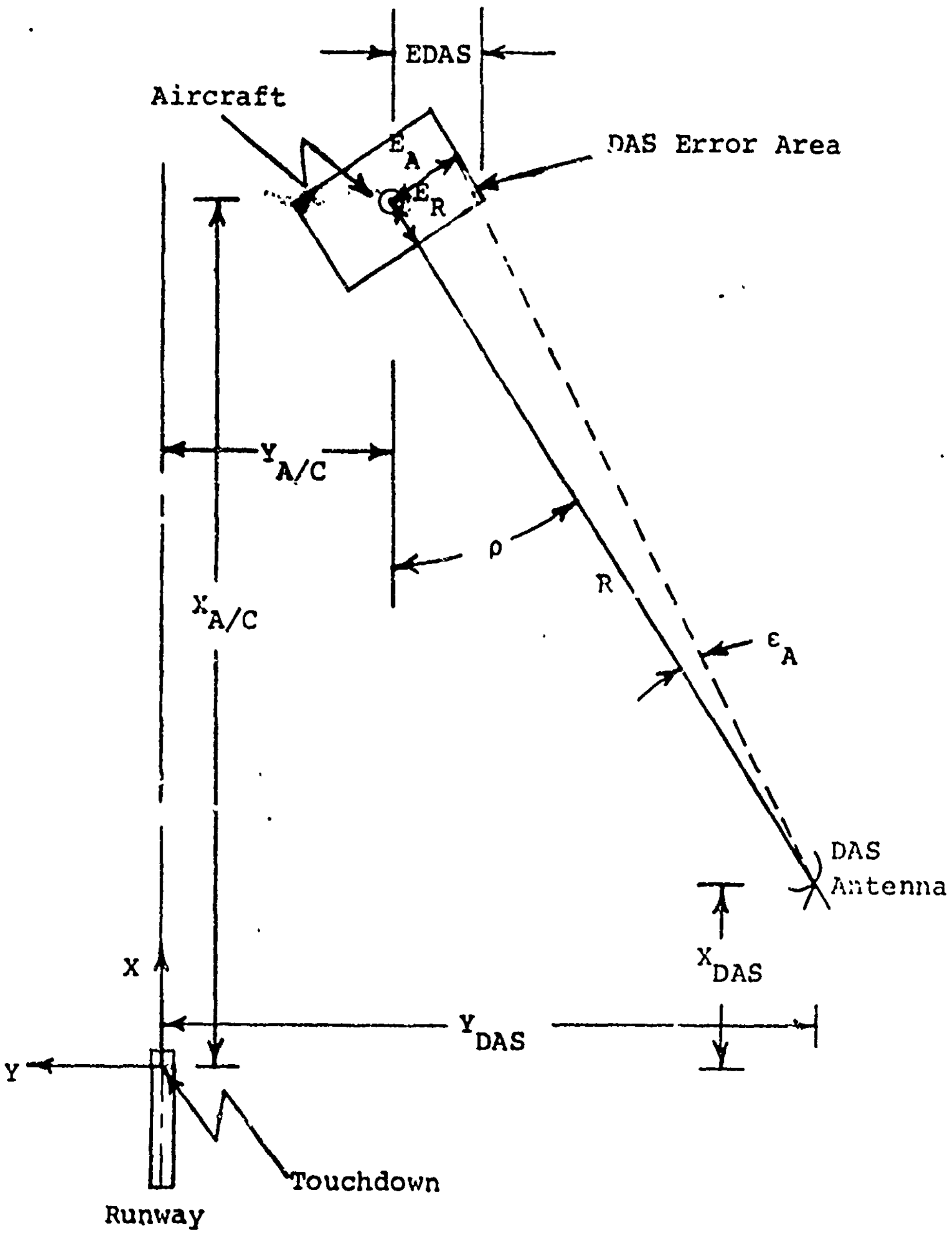


Figure D-2 DAS Configuration

Blundered Bank Angle (deg.) - the bank angle that the blundered aircraft uses to make the corrective maneuver.

Blundered Summed Delays (sec.) - a total of all the delays of the blundered aircraft, including DAS Update Delay, Communication Time, and Pilot/Aircraft Reaction Time.

Adjacent Summed Delays (sec.) - a total of all the delays of the adjacent aircraft, including the Communication Time and Pilot/Aircraft Reaction Time measured from the time $controller_1$ communicates to $controller_2$. This occurs at the end of the Blundered Summed Delays.

Corrected Parallel Headings (deg.) - the heading angle of both the blundered and adjacent aircraft at the point in time when they are flying parallel courses (i.e., the blunder is corrected).

Blunder Correction Time (sec.) - the total time required for a blundered aircraft to attain a flight course parallel with that of the aircraft on the adjacent course (total blunder recovery time measured from the time the blundered aircraft reaches the action point until the blunder is corrected).

Blunder Recovery Airspace (ft.) - the lateral recovery airspace, excluding EDAS, required for a blundered aircraft to recover to a course parallel with that of the adjacent aircraft. The blunder recovery airspace is measured from the action point perpendicular to the extended runway centerline.

The dual aircraft analysis assumed that the heading of the adjacent aircraft was equal to 180 degrees (the assumed runway heading) and that the turn rate of the adjacent aircraft was equal to 3.0 degrees per second. It should be noted that the blunder recovery airspace does not always vary with a change of the adjacent summed delays. This condition is due to the blundered aircraft correcting its heading error before the adjacent aircraft has time to start a maneuver.

Table D-3

Dual Aircraft Blunder Analysis Output

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ********** PAGE = 1

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
10.00	60.00	40.00	2.50	1.00	180.00	3.15	49.73
10.00	60.00	40.00	2.50	4.00	180.00	3.15	49.73
10.00	60.00	40.00	2.50	7.00	180.00	3.15	49.73
10.00	60.00	40.00	2.50	10.00	180.00	3.15	49.73
10.00	60.00	40.00	9.00	1.00	180.00	9.65	164.03
10.00	60.00	40.00	9.00	4.00	180.00	9.65	164.03
10.00	60.00	40.00	9.00	7.00	180.00	9.65	164.03
10.00	60.00	40.00	9.00	10.00	180.00	9.65	164.03
10.00	60.00	40.00	16.00	1.00	180.00	16.65	287.13
10.00	60.00	40.00	16.00	4.00	180.00	16.65	287.13
10.00	60.00	40.00	16.00	7.00	180.00	16.65	287.13
10.00	60.00	40.00	16.00	10.00	180.00	16.65	287.13
10.00	60.00	40.00	22.00	1.00	180.00	22.65	392.64
10.00	60.00	40.00	22.00	4.00	180.00	22.65	392.64
10.00	60.00	40.00	22.00	7.00	180.00	22.65	392.64
10.00	60.00	40.00	22.00	10.00	180.00	22.65	392.64
10.00	60.00	30.00	2.50	1.00	180.00	3.45	52.34
10.00	60.00	30.00	2.50	4.00	180.00	3.45	52.34
10.00	60.00	30.00	2.50	7.00	180.00	3.45	52.34
10.00	60.00	30.00	2.50	10.00	180.00	3.45	52.34
10.00	60.00	30.00	9.00	1.00	180.00	9.95	166.65
10.00	60.00	30.00	9.00	4.00	180.00	9.95	166.65
10.00	60.00	30.00	9.00	7.00	180.00	9.95	166.65
10.00	60.00	30.00	9.00	10.00	180.00	9.95	166.65
10.00	60.00	30.00	16.00	1.00	180.00	16.95	289.74
10.00	60.00	30.00	16.00	4.00	180.00	16.95	289.74
10.00	60.00	30.00	16.00	7.00	180.00	16.95	289.74
10.00	60.00	30.00	16.00	10.00	180.00	16.95	289.74
10.00	60.00	30.00	22.00	1.00	180.00	22.95	395.25
10.00	60.00	30.00	22.00	4.00	180.00	22.95	395.25
10.00	60.00	30.00	22.00	7.00	180.00	22.95	395.25
10.00	60.00	30.00	22.00	10.00	180.00	22.95	395.25

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ********** PAGE = 2

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
10.00	60.00	20.00	2.50	1.00	178.95	3.85	57.11
10.00	60.00	20.00	2.50	4.00	180.00	4.01	57.26
10.00	60.00	20.00	2.50	7.00	180.00	4.01	57.26
10.00	60.00	20.00	2.50	10.00	180.00	4.01	57.26
10.00	60.00	20.00	9.00	1.00	178.95	10.35	171.41
10.00	60.00	20.00	9.00	4.00	180.00	10.51	171.56
10.00	60.00	20.00	9.00	7.00	180.00	10.51	171.56
10.00	60.00	20.00	9.00	10.00	180.00	10.51	171.56
10.00	60.00	20.00	16.00	1.00	178.95	17.35	294.51
10.00	60.00	20.00	16.00	4.00	180.00	17.51	294.65
10.00	60.00	20.00	16.00	7.00	180.00	17.51	294.65
10.00	60.00	20.00	16.00	10.00	180.00	17.51	294.65
10.00	60.00	20.00	22.00	1.00	178.95	23.35	400.02
10.00	60.00	20.00	22.00	4.00	180.00	23.51	400.16
10.00	60.00	20.00	22.00	7.00	180.00	23.51	400.16
10.00	60.00	20.00	22.00	10.00	180.00	23.51	400.16
10.00	60.00	10.00	2.50	1.00	176.72	4.59	68.45
10.00	60.00	10.00	2.50	4.00	180.00	5.61	71.40
10.00	60.00	10.00	2.50	7.00	180.00	5.61	71.40
10.00	60.00	10.00	2.50	10.00	180.00	5.61	71.40
10.00	60.00	10.00	9.00	1.00	176.72	11.09	182.75
10.00	60.00	10.00	9.00	4.00	180.00	12.11	185.71
10.00	60.00	10.00	9.00	7.00	180.00	12.11	185.71
10.00	60.00	10.00	9.00	10.00	180.00	12.11	185.71
10.00	60.00	10.00	16.00	1.00	176.72	18.09	305.85
10.00	60.00	10.00	16.00	4.00	180.00	19.11	308.80
10.00	60.00	10.00	16.00	7.00	180.00	19.11	308.80
10.00	60.00	10.00	16.00	10.00	180.00	19.11	308.80
10.00	60.00	10.00	22.00	1.00	176.72	24.09	411.36
10.00	60.00	10.00	22.00	4.00	180.00	25.11	414.31
10.00	60.00	10.00	22.00	7.00	180.00	25.11	414.31
10.00	60.00	10.00	22.00	10.00	180.00	25.11	414.31

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
10.00	80.00	40.00	2.50	1.00	180.00	3.37	68.87
10.00	80.00	40.00	2.50	4.00	180.00	3.37	68.87
10.00	80.00	40.00	2.50	7.00	180.00	3.37	68.87
10.00	80.00	40.00	2.50	10.00	180.00	3.37	68.87
10.00	80.00	40.00	9.00	1.00	180.00	9.87	221.27
10.00	80.00	40.00	9.00	4.00	180.00	9.87	221.27
10.00	80.00	40.00	9.00	7.00	180.00	9.87	221.27
10.00	80.00	40.00	9.00	10.00	180.00	9.87	221.27
10.00	80.00	40.00	16.00	1.00	180.00	16.87	385.40
10.00	80.00	40.00	16.00	4.00	180.00	16.87	385.40
10.00	80.00	40.00	16.00	7.00	180.00	16.87	385.40
10.00	80.00	40.00	16.00	10.00	180.00	16.87	385.40
10.00	80.00	40.00	22.00	1.00	180.00	22.87	526.08
10.00	80.00	40.00	22.00	4.00	180.00	22.87	526.08
10.00	80.00	40.00	22.00	7.00	180.00	22.87	526.08
10.00	80.00	40.00	22.00	10.00	180.00	22.87	526.08
10.00	80.00	30.00	2.50	1.00	179.42	3.69	73.47
10.00	80.00	30.00	2.50	4.00	180.00	3.77	73.52
10.00	80.00	30.00	2.50	7.00	180.00	3.77	73.52
10.00	80.00	30.00	2.50	10.00	180.00	3.77	73.52
10.00	80.00	30.00	9.00	1.00	179.42	10.19	225.87
10.00	80.00	30.00	9.00	4.00	180.00	10.27	225.92
10.00	80.00	30.00	9.00	7.00	180.00	10.27	225.92
10.00	80.00	30.00	9.00	10.00	180.00	10.27	225.92
10.00	80.00	30.00	16.00	1.00	179.42	17.19	390.05
10.00	80.00	30.00	16.00	4.00	180.00	17.27	390.05
10.00	80.00	30.00	16.00	7.00	180.00	17.27	390.05
10.00	80.00	30.00	16.00	10.00	180.00	17.27	390.05
10.00	80.00	30.00	22.00	1.00	179.42	23.19	530.68
10.00	80.00	30.00	22.00	4.00	180.00	23.27	530.73
10.00	80.00	30.00	22.00	7.00	180.00	23.27	530.73
10.00	80.00	30.00	22.00	10.00	180.00	23.27	530.73

*********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ********** PAGE = 4

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
10.00	80.00	20.00	2.50	1.00	178.11	4.13	81.40
10.00	80.00	20.00	2.50	4.00	180.00	4.51	82.25
10.00	80.00	20.00	2.50	7.00	180.00	4.51	82.25
10.00	80.00	20.00	2.50	10.00	180.00	4.51	82.25
10.00	80.00	20.00	9.00	1.00	178.11	10.63	233.81
10.00	80.00	20.00	9.00	4.00	180.00	11.01	234.65
10.00	80.00	20.00	9.00	7.00	180.00	11.01	234.65
10.00	80.00	20.00	9.00	10.00	180.00	11.01	234.65
10.00	80.00	20.00	16.00	1.00	178.11	17.63	397.93
10.00	80.00	20.00	16.00	4.00	180.00	18.01	398.78
10.00	80.00	20.00	16.00	7.00	180.00	18.01	398.78
10.00	80.00	20.00	16.00	10.00	180.00	18.01	398.78
10.00	80.00	20.00	22.00	1.00	178.11	23.63	538.61
10.00	80.00	20.00	22.00	4.00	180.00	24.01	539.46
10.00	80.00	20.00	22.00	7.00	180.00	24.01	539.46
10.00	80.00	20.00	22.00	10.00	180.00	24.01	539.46
10.00	80.00	10.00	2.50	1.00	175.79	4.90	98.74
10.00	80.00	10.00	2.50	4.00	179.80	6.57	107.38
10.00	80.00	10.00	2.50	7.00	180.00	6.65	107.40
10.00	80.00	10.00	2.50	10.00	180.00	6.65	107.40
10.00	80.00	10.00	9.00	1.00	175.79	11.40	251.14
10.00	80.00	10.00	9.00	4.00	179.80	13.07	259.78
10.00	80.00	10.00	9.00	7.00	180.00	13.15	259.80
10.00	80.00	10.00	9.00	10.00	180.00	13.15	259.80
10.00	80.00	10.00	16.00	1.00	175.79	18.40	415.27
10.00	80.00	10.00	16.00	4.00	179.80	20.07	423.91
10.00	80.00	10.00	16.00	7.00	180.00	20.15	423.93
10.00	80.00	10.00	16.00	10.00	180.00	20.15	423.93
10.00	80.00	10.00	22.00	1.00	175.79	24.40	555.95
10.00	80.00	10.00	22.00	4.00	179.80	26.07	564.59
10.00	80.00	10.00	22.00	7.00	180.00	26.15	564.61
10.00	80.00	10.00	22.00	10.00	180.00	26.15	564.61

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ********** PAGE = 5

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
10.00	100.00	40.00	2.50	1.00	179.80	3.57	89.28
10.00	100.00	40.00	2.50	4.00	180.00	3.59	89.29
10.00	100.00	40.00	2.50	7.00	180.00	3.59	89.29
10.00	100.00	40.00	2.50	10.00	180.00	3.59	89.29
10.00	100.00	40.00	9.00	1.00	179.80	10.07	279.79
10.00	100.00	40.00	9.00	4.00	180.00	10.09	279.79
10.00	100.00	40.00	9.00	7.00	180.00	10.09	279.79
10.00	100.00	40.00	9.00	10.00	180.00	10.09	279.79
10.00	100.00	40.00	16.00	1.00	179.80	17.07	484.95
10.00	100.00	40.00	16.00	4.00	180.00	17.09	484.95
10.00	100.00	40.00	16.00	7.00	180.00	17.09	484.95
10.00	100.00	40.00	16.00	10.00	180.00	17.09	484.95
10.00	100.00	40.00	22.00	1.00	179.80	23.07	660.80
10.00	100.00	40.00	22.00	4.00	180.00	23.09	660.80
10.00	100.00	40.00	22.00	7.00	180.00	23.09	660.80
10.00	100.00	40.00	22.00	10.00	180.00	23.09	660.80
10.00	100.00	30.00	2.50	1.00	178.81	3.90	96.22
10.00	100.00	30.00	2.50	4.00	180.00	4.08	96.55
10.00	100.00	30.00	2.50	7.00	180.00	4.08	96.55
10.00	100.00	30.00	2.50	10.00	180.00	4.08	96.55
10.00	100.00	30.00	9.00	1.00	178.81	10.40	286.73
10.00	100.00	30.00	9.00	4.00	180.00	10.58	287.06
10.00	100.00	30.00	9.00	7.00	180.00	10.58	287.06
10.00	100.00	30.00	9.00	10.00	180.06	10.58	287.06
10.00	100.00	30.00	16.00	1.00	178.81	17.40	491.88
10.00	100.00	30.00	16.00	4.00	180.00	17.58	492.21
10.00	100.00	30.00	16.00	7.00	180.00	17.58	492.21
10.00	100.00	30.00	16.00	10.00	180.00	17.58	492.21
10.00	100.00	30.00	22.00	1.00	178.81	23.40	667.73
10.00	100.00	30.00	22.00	4.00	180.00	23.58	668.06
10.00	100.00	30.00	22.00	7.00	180.00	23.58	668.06
10.00	100.00	30.00	22.00	10.00	180.00	23.58	668.06

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ********** PAGE = 6

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
10.00	100.00	20.00	2.50	1.00	177.41	4.36	107.72
10.00	100.00	20.00	2.50	4.00	180.00	5.01	110.20
10.00	100.00	20.00	2.50	7.00	180.00	5.01	110.20
10.00	100.00	20.00	2.50	10.00	180.00	5.01	110.20
10.00	100.00	20.00	9.00	1.00	177.41	10.86	298.22
10.00	100.00	20.00	9.00	4.00	180.00	11.51	300.70
10.00	100.00	20.00	9.00	7.00	180.00	11.51	300.70
10.00	100.00	20.00	9.00	10.00	180.00	11.51	300.70
10.00	100.00	20.00	16.00	1.00	177.41	17.86	503.38
10.00	100.00	20.00	16.00	4.00	180.00	18.51	505.86
10.00	100.00	20.00	16.00	7.00	180.00	18.51	505.86
10.00	100.00	20.00	16.00	10.00	180.00	18.51	505.86
10.00	100.00	20.00	22.00	1.00	177.41	23.86	679.23
10.00	100.00	20.00	22.00	4.00	180.00	24.51	681.71
10.00	100.00	20.00	22.00	7.00	180.00	24.51	681.71
10.00	100.00	20.00	22.00	10.00	180.00	24.51	681.71
10.00	100.00	10.00	2.50	1.50	175.09	5.14	131.05
10.00	100.00	10.00	2.50	4.00	178.61	6.96	148.01
10.00	100.00	10.00	2.50	7.00	180.00	7.69	149.50
10.00	100.00	10.00	2.50	10.00	180.00	7.69	149.50
10.00	100.00	10.00	9.00	1.00	175.09	[illegible]	[illegible]
10.00	100.00	10.00	9.00	4.00	178.61	13.46	[illegible]
10.00	100.00	10.00	9.00	7.00	180.00	14.19	340.00
10.00	100.00	10.00	9.00	10.00	180.00	14.19	340.00
10.00	100.00	10.00	16.00	1.00	175.09	18.64	526.71
10.00	100.00	10.00	16.00	4.00	178.61	20.46	543.67
10.00	100.00	10.00	16.00	7.00	180.00	21.19	545.16
10.00	100.00	10.00	16.00	10.00	180.00	21.19	545.16
10.00	100.00	10.00	22.00	1.00	175.09	24.64	702.56
10.00	100.00	10.00	22.00	4.00	178.61	26.46	719.52
10.00	100.00	10.00	22.00	7.00	180.00	27.19	721.01
10.00	100.00	10.00	22.00	10.00	180.00	27.19	721.01

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ********** PAGE = 7

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
10.00	120.00	40.00	2.50	1.00	179.34	3.72	110.89
10.00	120.00	40.00	2.50	4.00	180.00	3.81	110.95
10.00	120.00	40.00	2.50	7.00	180.00	3.81	110.99
10.00	120.00	40.00	2.50	10.00	180.00	3.81	110.99
10.00	120.00	40.00	9.00	1.00	179.34	10.22	339.49
10.00	120.00	40.00	9.00	4.00	180.00	10.31	339.60
10.00	120.00	40.00	9.00	7.00	180.00	10.31	339.60
10.00	120.00	40.00	9.00	10.00	180.00	10.31	339.60
10.00	120.00	40.00	16.00	1.00	179.34	17.22	585.68
10.00	120.00	40.00	16.00	4.00	180.00	17.31	585.79
10.00	120.00	40.00	16.00	7.00	180.00	17.31	585.79
10.00	120.00	40.00	16.00	10.00	180.00	17.31	585.79
10.00	120.00	40.00	22.00	1.00	179.34	23.22	796.71
10.00	120.00	40.00	22.00	4.00	180.00	23.31	796.81
10.00	120.00	40.00	22.00	7.00	180.00	23.31	796.81
10.00	120.00	40.00	22.00	10.00	180.00	23.31	796.81
10.00	120.00	30.00	2.50	1.00	178.28	4.07	120.45
10.00	120.00	30.00	2.50	4.00	180.00	4.40	121.45
10.00	120.00	30.00	2.50	7.00	180.00	4.40	121.45
10.00	120.00	30.00	2.50	10.00	180.00	4.40	121.45
10.00	120.00	30.00	9.00	1.00	178.28	10.57	349.06
10.00	120.00	30.00	9.00	4.00	180.00	10.90	350.05
10.00	120.00	30.00	9.00	7.00	180.00	10.90	350.05
10.00	120.00	30.00	9.00	10.00	180.00	10.90	350.05
10.00	120.00	30.00	16.00	1.00	178.28	17.57	595.25
10.00	120.00	30.00	16.00	4.00	180.00	17.90	596.24
10.00	120.00	30.00	16.00	7.00	180.00	17.90	596.24
10.00	120.00	30.00	16.00	10.00	180.00	17.90	596.24
10.00	120.00	30.00	22.00	1.00	178.26	23.57	806.27
10.00	120.00	30.00	22.00	4.00	180.00	23.90	807.26
10.00	120.00	30.00	22.00	7.00	180.00	23.90	807.26
10.00	120.00	30.00	22.00	10.00	180.00	23.90	807.26

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER **********   P, G_L = 8

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
10.00	120.00	20.00	2.50	1.00	176.82	4.56	135.73
10.00	120.00	20.00	2.50	4.00	180.00	5.52	141.10
10.00	120.00	20.00	2.50	7.00	180.00	5.52	141.10
10.00	120.00	20.00	2.50	10.00	180.00	5.52	141.10
10.00	120.00	20.00	9.00	1.00	176.82	11.06	364.33
10.00	120.00	20.00	9.00	4.00	180.00	12.02	369.71
10.00	120.00	20.00	9.00	7.00	180.00	12.02	369.71
10.00	120.00	20.00	9.00	10.00	180.00	12.02	369.71
10.00	120.00	20.00	16.00	1.00	176.82	18.06	610.52
10.00	120.00	20.00	16.00	4.00	180.00	19.02	615.90
10.00	120.00	20.00	16.00	7.00	180.00	19.02	615.90
10.00	120.00	20.00	16.00	10.00	180.00	19.02	615.90
10.00	120.00	20.00	22.00	1.00	176.82	24.06	821.54
10.00	120.00	20.00	22.00	4.00	180.00	25.02	826.92
10.00	120.00	20.00	22.00	7.00	180.00	25.02	826.92
10.00	120.00	20.00	22.00	10.00	180.00	25.02	826.92
10.00	120.00	10.00	2.50	1.00	174.53	5.32	164.82
10.00	120.00	10.00	2.50	4.00	177.67	7.28	191.72
10.00	120.00	10.00	2.50	7.00	180.00	8.73	197.69
10.00	120.00	10.00	2.50	10.00	180.00	8.73	197.69
10.00	120.00	10.00	9.00	1.00	174.53	11.82	393.43
10.00	120.00	10.00	9.00	4.00	177.67	13.78	420.33
10.00	120.00	10.00	9.00	7.00	180.00	15.23	426.29
10.00	120.00	10.00	9.00	10.00	180.00	15.23	426.29
10.00	120.00	10.00	16.00	1.00	174.53	18.82	639.62
10.00	120.00	10.00	16.00	4.00	177.67	20.78	666.52
10.00	120.00	10.00	16.00	7.00	180.00	22.23	672.48
10.00	120.00	10.00	16.00	10.00	180.00	22.23	672.48
10.00	120.00	10.00	22.00	1.00	174.53	24.82	850.64
10.00	120.00	10.00	22.00	4.00	177.67	26.78	877.54
10.00	120.00	10.00	22.00	7.00	180.00	28.23	883.50
10.00	120.00	10.00	22.00	10.00	180.00	28.23	883.50

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
10.00	140.00	40.00	2.50	1.00	178.92	3.86	133.60
10.00	140.00	40.00	2.50	4.00	180.00	4.03	133.97
10.00	140.00	40.00	2.50	7.00	180.00	4.03	133.97
10.00	140.00	40.00	2.50	10.00	180.00	4.03	133.97
10.00	140.00	40.00	9.00	1.00	178.92	10.36	400.31
10.00	140.00	40.00	9.00	4.00	180.00	10.53	400.68
10.00	140.00	40.00	9.00	7.00	180.00	10.53	400.68
10.00	140.00	40.00	9.00	10.00	180.00	10.53	400.68
10.00	140.00	40.00	16.00	1.00	178.92	17.36	687.53
10.00	140.00	40.00	16.00	4.00	180.00	17.53	687.90
10.00	140.00	40.00	16.00	7.00	180.00	17.53	687.90
10.00	140.00	40.00	16.00	10.00	180.00	17.53	687.90
10.00	140.00	40.00	22.00	1.00	178.92	23.36	933.72
10.00	140.00	40.00	22.00	4.00	180.00	23.53	934.09
10.00	140.00	40.00	22.00	7.00	180.00	23.53	934.09
10.00	140.00	40.00	22.00	10.00	180.00	23.53	934.09
10.00	140.00	30.00	2.50	1.00	177.81	4.23	146.00
10.00	140.00	30.00	2.50	4.00	180.00	4.72	148.21
10.00	140.00	30.00	2.50	7.00	180.00	4.72	148.21
10.00	140.00	30.00	2.50	10.00	180.00	4.72	148.21
10.00	140.00	30.00	9.00	1.00	177.81	10.73	412.71
10.00	140.00	30.00	9.00	4.00	180.00	11.22	414.91
10.00	140.00	30.00	9.00	7.00	180.00	11.22	414.91
10.00	140.00	30.00	9.00	10.00	180.00	11.22	414.91
10.00	140.00	30.00	16.00	1.00	177.81	17.73	699.93
10.00	140.00	30.00	16.00	4.00	180.00	18.22	702.14
10.00	140.00	30.00	16.00	7.00	180.00	18.22	702.14
10.00	140.00	30.00	16.00	10.00	180.00	18.22	702.14
10.00	140.00	30.00	22.00	1.00	177.81	23.73	946.12
10.00	140.00	30.00	22.00	4.00	180.00	24.22	948.33
10.00	140.00	30.00	22.00	7.00	180.00	24.22	948.33
10.00	140.00	30.00	22.00	10.00	180.00	24.22	948.33

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
10.00	140.00	20.00	2.50	1.00	176.32	4.73	165.15
10.00	140.00	20.00	2.50	4.00	180.00	6.02	174.96
10.00	140.00	20.00	2.50	7.00	180.00	6.02	174.96
10.00	140.00	20.00	2.50	10.00	180.00	6.02	174.96
10.00	140.00	20.00	9.00	1.00	176.32	11.23	431.86
10.00	140.00	20.00	9.00	4.00	180.00	12.52	441.66
10.00	140.00	20.00	9.00	7.00	180.00	12.52	441.66
10.00	140.00	20.00	9.00	10.00	180.00	12.52	441.66
10.00	140.00	20.00	16.00	1.00	176.32	18.23	719.08
10.00	140.00	20.00	16.00	4.00	180.00	19.52	728.89
10.00	140.00	20.00	16.00	7.00	180.00	19.52	728.89
10.00	140.00	20.00	16.00	10.00	180.00	19.52	728.89
10.00	140.00	20.00	22.00	1.00	176.32	24.23	965.27
10.00	140.00	20.00	22.00	4.00	180.00	25.52	975.08
10.00	140.00	20.00	22.00	7.00	180.00	25.52	975.08
10.00	140.00	20.00	22.00	10.00	180.00	25.52	975.08
10.00	140.00	10.00	2.50	1.00	174.09	5.47	199.70
10.00	140.00	10.00	2.50	4.00	176.92	7.53	237.78
10.00	140.00	10.00	2.50	7.00	179.75	9.58	251.89
10.00	140.00	10.00	2.50	10.00	180.00	9.76	251.98
10.00	140.00	10.00	9.00	1.00	174.09	11.97	466.40
10.00	140.00	10.00	9.00	4.00	176.92	14.03	504.48
10.00	140.00	10.00	9.00	7.00	179.75	16.08	518.59
10.00	140.00	10.00	9.00	10.00	180.00	16.26	518.69
10.00	140.00	10.00	16.00	1.00	174.09	18.97	753.63
10.00	140.00	10.00	16.00	4.00	176.92	21.03	791.70
10.00	140.00	10.00	16.00	7.00	179.75	23.08	805.81
10.00	140.00	10.00	16.00	10.00	180.00	23.26	805.91
10.00	140.00	10.00	22.00	1.00	174.09	24.97	999.82
10.00	140.00	10.00	22.00	4.00	176.92	27.03	1037.89
10.00	140.00	10.00	22.00	7.00	179.75	29.08	1052.01
10.00	140.00	10.00	22.00	10.00	180.00	29.26	1052.10

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER **********

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
10.00	160.00	40.00	2.50	1.00	178.53	3.99	157.36
10.00	160.00	40.00	2.50	4.00	180.00	4.24	158.24
10.00	160.00	40.00	2.50	7.00	180.00	4.24	158.24
10.00	160.00	40.00	2.50	10.00	180.00	4.24	158.24
10.00	160.00	40.00	9.00	1.00	178.53	10.49	462.16
10.00	160.00	40.00	9.00	4.00	180.00	10.74	463.05
10.00	160.00	40.00	9.00	7.00	180.00	10.74	463.05
10.00	160.00	40.00	9.00	10.00	180.00	10.74	463.05
10.00	160.00	40.00	16.00	1.00	178.53	17.49	790.42
10.00	160.00	40.00	16.00	4.00	180.00	17.74	791.30
10.00	160.00	40.00	16.00	7.00	180.00	17.74	791.30
10.00	160.00	40.00	16.00	10.00	180.00	17.74	791.30
10.00	160.00	40.00	22.00	1.00	178.53	23.49	1071.78
10.00	160.00	40.00	22.00	4.00	180.00	23.74	1072.66
10.00	160.00	40.00	22.00	7.00	180.00	23.74	1072.66
10.00	160.00	40.00	22.00	10.00	180.00	23.74	1072.66
10.00	160.00	30.00	2.50	1.00	177.38	4.37	172.74
10.00	160.00	30.00	2.50	4.00	180.00	5.04	176.83
10.00	160.00	30.00	2.50	7.00	180.00	5.04	176.83
10.00	160.00	30.00	2.50	10.00	180.00	5.04	176.83
10.00	160.00	30.00	9.00	1.00	177.38	10.87	477.55
10.00	160.00	30.00	9.00	4.00	180.00	11.54	481.64
10.00	160.00	30.00	9.00	7.00	180.00	11.54	481.64
10.00	160.00	30.00	9.00	10.00	180.00	11.54	481.64
10.00	160.00	30.00	16.00	1.00	177.38	17.87	805.80
10.00	160.00	30.00	16.00	4.00	180.00	18.54	809.89
10.00	160.00	30.00	16.00	7.00	180.00	18.54	809.89
10.00	160.00	30.00	16.00	10.00	180.00	18.54	809.89
10.00	160.00	30.00	22.00	1.00	177.38	23.87	1087.16
10.00	160.00	30.00	22.00	4.00	180.00	24.54	1091.25
10.00	160.00	30.00	22.00	7.00	180.00	24.54	1091.25
10.00	160.00	30.00	22.00	10.00	180.00	24.54	1091.25

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
10.00	160.00	20.00	2.50	1.00	175.89	4.87	195.78
10.00	160.00	20.00	2.50	4.00	179.97	6.51	211.77
10.00	160.00	20.00	2.50	7.00	180.00	6.52	211.77
10.00	160.00	20.00	2.50	10.00	180.00	6.52	211.77
10.00	160.00	20.00	9.00	1.00	175.89	11.37	500.59
10.00	160.00	20.00	9.00	4.00	179.97	13.01	516.57
10.00	160.00	20.00	9.00	7.00	180.00	13.02	516.57
10.00	160.00	20.00	9.00	10.00	180.00	13.02	516.57
10.00	160.00	20.00	16.00	1.00	175.89	18.37	828.84
10.00	160.00	20.00	16.00	4.00	179.97	20.01	844.83
10.00	160.00	20.00	16.00	7.00	180.00	20.02	844.83
10.00	160.00	20.00	16.00	10.00	180.00	20.02	844.83
10.00	160.00	20.00	22.00	1.00	175.89	24.37	1110.20
10.00	160.00	20.00	22.00	4.00	179.97	26.01	1126.19
10.00	160.00	20.00	22.00	7.00	180.00	26.02	1126.19
10.00	160.00	20.00	22.00	10.00	180.00	26.02	1126.19
10.00	160.00	10.00	2.50	1.00	173.72	5.59	235.40
10.00	160.00	10.00	2.50	4.00	176.30	7.73	285.64
10.00	160.00	10.00	2.50	7.00	178.88	9.87	309.92
10.00	160.00	10.00	2.50	10.00	180.00	10.80	312.37
10.00	160.00	10.00	9.00	1.00	173.72	12.09	540.21
10.00	160.00	10.00	9.00	4.00	176.30	14.23	590.45
10.00	160.00	10.00	9.00	7.00	178.88	16.37	614.73
10.00	160.00	10.00	9.00	10.00	180.00	17.30	617.17
10.00	160.00	10.00	16.00	1.00	173.72	19.09	868.46
10.00	160.00	10.00	16.00	4.00	176.30	21.23	918.70
10.00	160.00	10.00	16.00	7.00	178.88	23.37	942.98
10.00	160.00	10.00	16.00	10.00	180.00	24.30	945.43
10.00	160.00	10.00	22.00	1.00	173.72	25.09	1149.82
10.00	160.00	10.00	22.00	4.00	176.30	27.23	1200.06
10.00	160.00	10.00	22.00	7.00	178.88	29.37	1224.34
10.00	160.00	10.00	22.00	10.00	180.00	30.30	1226.79

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER **********

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADING (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
15.00	60.00	40.00	2.50	1.00	180.00	3.48	73.46
15.00	60.00	40.00	2.50	4.00	130.00	3.48	78.46
15.00	60.00	40.00	2.50	7.00	180.00	3.48	78.46
15.00	60.00	40.00	2.50	10.00	180.00	3.48	78.46
15.00	60.00	40.00	9.00	1.00	180.00	9.98	248.82
15.00	60.00	40.00	9.00	4.00	180.00	9.93	248.82
15.00	60.00	40.00	9.00	7.00	180.00	9.98	248.82
15.00	60.00	40.00	9.00	10.00	180.00	9.98	248.82
15.00	60.00	40.00	16.00	1.00	180.00	16.98	432.30
15.00	60.00	40.00	16.00	4.00	180.00	16.98	432.30
15.00	60.00	40.00	16.00	7.00	180.00	16.98	432.30
15.00	60.00	40.00	16.00	10.00	180.00	16.98	432.30
15.00	60.00	40.00	22.00	1.00	180.00	22.98	589.56
15.00	60.00	40.00	22.00	4.00	180.00	22.98	589.56
15.00	60.00	40.00	22.00	7.00	180.00	22.98	589.56
15.00	60.00	40.00	22.00	10.00	180.00	22.98	589.56
15.00	60.00	30.00	2.50	1.00	179.01	3.83	84.24
15.00	60.00	30.00	2.50	4.00	180.00	3.93	84.32
15.00	60.00	30.00	2.50	7.00	180.00	3.93	64.32
15.00	60.00	30.00	2.50	10.00	180.00	3.93	84.32
15.00	60.00	30.00	9.00	1.00	179.01	10.33	254.60
15.00	60.00	30.00	9.00	4.00	180.00	10.43	254.69
15.00	60.00	30.00	9.00	7.00	180.00	10.43	254.69
15.00	60.00	30.00	9.00	10.00	180.00	10.43	254.69
15.00	60.00	30.00	16.00	1.00	179.01	17.33	438.08
15.00	60.00	30.00	16.00	4.00	180.00	17.43	438.16
15.00	60.00	30.00	16.00	7.00	180.00	17.43	438.16
15.00	60.00	30.00	16.00	10.00	180.00	17.43	438.16
15.00	60.00	30.00	22.00	1.00	179.01	23.33	595.34
15.00	60.00	30.00	22.00	4.00	180.00	23.43	595.42
15.00	60.00	30.00	22.00	7.00	180.00	23.43	595.42
15.00	60.00	30.00	22.00	10.00	180.00	23.43	595.42

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ********** PAGE = 14

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
15.00	60.00	20.00	2.50	1.00	177.39	4.37	94.44
15.00	60.00	20.00	2.50	4.00	180.00	4.76	95.34
15.00	60.00	20.00	2.50	7.00	180.00	4.76	95.34
15.00	60.00	20.00	2.50	10.00	180.00	4.76	95.34
15.00	60.00	20.00	9.00	1.00	177.39	10.87	264.80
15.00	60.00	20.00	9.00	4.00	180.00	11.26	265.71
15.00	60.00	20.00	9.00	7.00	180.00	11.26	265.71
15.00	60.00	20.00	9.00	10.00	180.00	11.26	265.71
15.00	60.00	20.00	16.00	1.00	177.39	17.87	448.27
15.00	60.00	20.00	16.00	4.00	180.00	18.26	449.18
15.00	60.00	20.00	16.00	7.00	180.00	18.26	449.18
15.00	60.00	20.00	16.00	10.00	180.00	18.26	449.18
15.00	60.00	20.00	22.00	1.00	177.39	23.87	605.53
15.00	60.00	20.00	22.00	4.00	180.00	24.26	606.44
15.00	60.00	20.00	22.00	7.00	180.00	24.26	606.44
15.00	60.00	20.00	22.00	10.00	180.00	24.26	606.44
15.00	60.00	10.00	2.50	1.00	174.31	5.40	118.16
15.00	60.00	10.00	2.50	4.00	178.96	6.85	126.77
15.00	60.00	10.00	2.50	7.00	180.00	7.17	127.07
15.00	60.00	10.00	2.50	10.00	180.00	7.17	127.07
15.00	60.00	10.00	9.00	1.00	174.31	11.90	288.53
15.00	60.00	10.00	9.00	4.00	178.96	13.35	297.14
15.00	60.00	10.00	9.00	7.00	180.00	13.67	297.44
15.00	60.00	10.00	9.00	10.00	180.00	13.67	297.44
15.00	60.00	10.00	16.00	1.00	174.31	18.90	472.00
15.00	60.00	10.00	16.00	4.00	178.96	20.35	480.61
15.00	60.00	10.00	16.00	7.00	180.00	20.67	480.91
15.00	60.00	10.00	16.00	10.00	180.00	20.67	480.91
15.00	60.00	10.00	22.00	1.00	174.31	24.90	629.26
15.00	60.00	10.00	22.00	4.00	178.96	26.35	637.87
15.00	60.00	10.00	22.00	7.00	180.00	26.67	638.17
15.00	60.00	10.00	22.00	10.00	180.00	26.67	638.17

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
15.00	80.00	40.00	2.50	1.00	179.27	3.74	110.30
15.00	80.00	40.00	2.50	4.00	180.00	3.81	110.36
15.00	80.00	40.00	2.50	7.00	180.00	3.81	110.36
15.00	80.00	40.00	2.50	10.00	180.00	3.81	110.36
15.00	80.00	40.00	9.00	1.00	179.27	10.24	337.46
15.00	80.00	40.00	9.00	4.00	180.00	10.31	337.51
15.00	80.00	40.00	9.00	7.00	180.00	10.31	337.51
15.00	80.00	40.00	9.00	10.00	180.00	10.31	337.51
15.00	80.00	40.00	16.00	1.00	179.27	17.24	582.09
15.00	80.00	40.00	16.00	4.00	180.00	17.31	582.14
15.00	80.00	40.00	16.00	7.00	180.00	17.31	582.14
15.00	80.00	40.00	16.00	10.00	180.00	17.31	582.14
15.00	80.00	40.00	22.00	1.00	179.27	23.24	791.77
15.00	80.00	40.00	22.00	4.00	180.00	23.31	791.82
15.00	80.00	40.00	22.00	7.00	180.00	23.31	791.82
15.00	80.00	40.00	22.00	10.00	180.00	23.31	791.82
15.00	80.00	30.00	2.50	1.00	178.04	4.15	120.21
15.00	80.00	30.00	2.50	4.00	180.00	4.40	120.78
15.00	80.00	30.00	2.50	7.00	180.00	4.40	120.78
15.00	80.00	30.00	2.50	10.00	180.00	4.40	120.78
15.00	80.00	30.00	9.00	1.00	178.04	10.65	347.36
15.00	80.00	30.00	9.00	4.00	180.00	10.90	347.94
15.00	80.00	30.00	9.00	7.00	180.00	10.90	347.94
15.00	80.00	30.00	9.00	10.00	180.00	10.90	347.94
15.00	80.00	30.00	16.00	1.00	178.04	17.65	591.99
15.00	80.00	30.00	16.00	4.00	180.00	17.90	592.57
15.00	80.00	30.00	16.00	7.00	180.00	17.90	592.57
15.00	80.00	30.00	16.00	10.00	180.00	17.90	592.57
15.00	80.00	30.00	22.00	1.00	178.04	23.65	801.67
15.00	80.00	30.00	22.00	4.00	180.00	23.90	802.25
15.00	80.00	30.00	22.00	7.00	180.00	23.90	802.25
15.00	80.00	30.00	22.00	10.00	180.00	23.90	802.25

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER **********

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
15.00	60.00	20.00	2.50	1.00	176.23	4.76	137.00
15.00	60.00	20.00	2.50	4.00	180.00	5.52	140.37
15.00	80.00	20.00	2.50	7.00	180.00	5.52	140.37
15.00	80.00	20.00	2.50	10.00	180.00	5.52	140.37
15.00	80.00	20.00	9.00	1.00	176.23	11.26	364.16
15.00	80.00	20.00	9.00	4.00	180.00	12.02	367.53
15.00	80.00	20.00	9.00	7.00	180.00	12.02	367.53
15.00	80.00	20.00	9.00	10.00	180.00	12.02	367.53
15.00	80.00	20.00	16.00	1.00	176.23	18.26	608.78
15.00	80.00	20.00	16.00	4.00	180.00	19.02	612.16
15.00	80.00	20.00	16.00	7.00	180.00	19.02	612.16
15.00	80.00	20.00	16.00	10.00	180.00	19.02	612.16
15.00	80.00	20.00	22.00	1.00	176.23	24.26	818.47
15.00	80.00	20.00	22.00	4.00	180.00	25.02	821.84
15.00	80.00	20.00	22.00	7.00	180.00	25.02	821.84
15.00	80.00	20.00	22.00	10.00	180.00	25.02	821.84
15.00	80.00	10.00	2.50	1.00	173.02	5.83	172.96
15.00	80.00	10.00	2.50	4.00	177.03	7.49	192.46
15.00	80.00	10.00	2.50	7.00	180.00	8.73	196.78
15.00	80.00	10.00	2.50	10.00	180.00	8.73	196.78
15.00	80.00	10.00	9.00	1.00	173.02	12.33	400.12
15.00	80.00	10.00	9.00	4.00	177.03	13.99	419.61
15.00	80.00	10.00	9.00	7.00	180.00	15.23	423.94
15.00	80.00	10.00	9.00	10.00	180.00	15.23	423.94
15.00	80.00	10.00	16.00	1.00	173.02	19.33	644.75
15.00	80.00	10.00	16.00	4.00	177.03	20.99	664.24
15.00	80.00	10.00	16.00	7.00	180.00	22.23	668.56
15.00	80.00	10.00	16.00	10.00	180.00	22.23	668.55
15.00	80.00	10.00	22.00	1.00	173.02	25.33	854.43
15.00	80.00	10.00	22.00	4.00	177.03	26.99	873.92
15.00	80.00	10.00	22.00	7.00	180.00	28.23	878.25
15.00	80.00	10.00	22.00	10.00	180.00	28.23	878.25

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
15.00	100.00	40.00	2.50	1.00	178.56	3.98	144.80
15.00	100.00	40.00	2.50	4.00	180.00	4.14	145.13
15.00	100.00	40.00	2.50	7.00	180.00	4.14	145.13
15.00	100.00	40.00	2.50	10.00	180.00	4.14	145.13
15.00	100.00	40.00	9.00	1.00	178.56	10.48	428.75
15.00	100.00	40.00	9.00	4.00	180.00	10.64	429.08
15.00	100.00	40.00	9.00	7.00	180.00	10.64	429.08
15.00	100.00	40.00	9.00	10.00	180.00	10.64	429.08
15.00	100.00	40.00	16.00	1.00	178.56	17.48	734.53
15.00	100.00	40.00	16.00	4.00	180.00	17.64	734.86
15.00	100.00	40.00	16.00	7.00	180.00	17.64	734.86
15.00	100.00	40.00	16.00	10.00	180.00	17.64	734.86
15.00	100.00	40.00	22.00	1.00	178.56	23.48	996.63
15.00	100.00	40.00	22.00	4.00	180.00	23.64	996.96
15.00	100.00	40.00	22.00	7.00	180.00	23.64	996.96
15.00	100.00	40.00	22.00	10.00	180.00	23.64	996.96
15.00	100.00	30.00	2.50	1.00	177.20	4.43	159.59
15.00	100.00	30.00	2.50	4.00	180.00	4.88	161.42
15.00	100.00	30.00	2.50	7.00	180.00	4.88	161.42
15.00	100.00	30.00	2.50	10.00	180.00	4.88	161.42
15.00	100.00	30.00	9.00	1.00	177.20	10.93	443.54
15.00	100.00	30.00	9.00	4.00	180.00	11.38	445.36
15.00	100.00	30.00	9.00	7.00	180.00	11.38	445.36
15.00	100.00	30.00	9.00	10.00	180.00	11.38	445.36
15.00	100.00	30.00	16.00	1.00	177.20	17.93	749.32
15.00	100.00	30.00	16.00	4.00	180.00	18.38	751.15
15.00	100.00	30.00	16.00	7.00	180.00	18.38	751.15
15.00	100.00	30.00	16.00	10.00	180.00	18.38	751.15
15.00	100.00	30.00	22.00	1.00	177.20	23.93	1011.42
15.00	100.00	30.00	22.00	4.00	180.00	24.38	1013.25
15.00	100.00	30.00	22.00	7.00	180.00	24.38	1013.25
15.00	100.00	30.00	22.00	10.00	180.00	24.38	1013.25

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
15.00	100.00	20.00	2.50	1.00	175.26	5.08	183.73
15.00	100.00	20.00	2.50	4.00	180.00	6.27	192.03
15.00	100.00	20.00	2.50	7.00	180.00	6.27	192.03
15.00	100.00	20.00	2.50	10.00	180.00	6.27	192.03
15.00	100.00	20.00	9.00	1.00	175.26	11.58	467.67
15.00	100.00	20.00	9.00	4.00	180.00	12.77	475.97
15.00	100.00	20.00	9.00	7.00	180.00	12.77	475.97
15.00	100.00	20.00	9.00	10.00	180.00	12.77	475.97
15.00	100.00	20.00	16.00	1.00	175.26	18.58	773.45
15.00	100.00	20.00	16.00	4.00	180.00	19.77	781.76
15.00	100.00	20.00	16.00	7.00	180.00	19.77	781.76
15.00	100.00	20.00	16.00	10.00	180.00	19.77	781.76
15.00	100.00	20.00	22.00	1.00	175.26	24.58	1035.56
15.00	100.00	20.00	22.00	4.00	180.00	25.77	1043.86
15.00	100.00	20.00	22.00	7.00	180.00	25.77	1043.86
15.00	100.00	20.00	22.00	10.00	180.00	25.77	1043.86
15.00	100.00	10.00	2.50	1.00	172.04	6.15	231.84
15.00	100.00	10.00	2.50	4.00	175.56	7.98	265.12
15.00	100.00	10.00	2.50	7.00	179.08	9.81	279.53
15.00	100.00	10.00	2.50	10.00	180.00	10.28	280.17
15.00	100.00	10.00	9.00	1.00	172.04	12.65	515.78
15.00	100.00	10.00	9.00	4.00	175.56	14.48	549.06
15.00	100.00	10.00	9.00	7.00	179.08	16.31	563.47
15.00	100.00	10.00	9.00	10.00	180.00	16.78	564.11
15.00	100.00	10.00	16.00	1.00	172.04	19.65	821.57
15.00	100.00	10.00	16.00	4.00	175.56	21.48	854.85
15.00	100.00	10.00	16.00	7.00	179.08	23.31	869.25
15.00	100.00	10.00	16.00	10.00	180.00	23.78	869.90
15.00	100.00	10.00	22.00	1.00	172.04	25.65	1083.67
15.00	100.00	10.00	22.00	4.00	175.56	27.48	1116.95
15.00	100.00	10.00	22.00	7.00	179.08	29.31	1131.35
15.00	100.00	10.00	22.00	10.00	180.00	29.78	1132.00

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BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
15.00	120.00	40.00	2.50	1.00	177.93	4.19	181.79
15.00	120.00	40.00	2.50	4.00	180.00	4.46	182.78
15.00	120.00	40.00	2.50	7.00	180.00	4.46	182.78
15.00	120.00	40.00	2.50	10.00	180.00	4.46	182.78
15.00	120.00	40.00	9.00	1.00	177.93	10.69	522.52
15.00	120.00	40.00	9.00	4.00	180.00	10.96	523.52
15.00	120.00	40.00	9.00	7.00	180.00	10.96	523.52
15.00	120.00	40.00	9.00	10.00	180.00	10.96	523.52
15.00	120.00	40.00	16.00	1.00	177.93	17.69	889.46
15.00	120.00	40.00	16.00	4.00	180.00	17.96	890.46
15.00	120.00	40.00	16.00	7.00	180.00	17.96	890.46
15.00	120.00	40.00	16.00	10.00	180.00	17.96	890.46
15.00	120.00	40.00	22.00	1.00	177.93	23.69	1203.98
15.00	120.00	40.00	22.00	4.00	180.00	23.96	1204.98
15.00	120.00	40.00	22.00	7.00	180.00	23.96	1204.98
15.00	120.00	40.00	22.00	10.00	180.00	23.96	1204.98
15.00	120.00	30.00	2.50	1.00	176.45	4.68	202.03
15.00	120.00	30.00	2.50	4.00	180.00	5.35	206.24
15.00	120.00	30.00	2.50	7.00	180.00	5.35	206.24
15.00	120.00	30.00	2.50	10.00	180.00	5.35	206.24
15.00	120.00	30.00	9.00	1.00	176.46	11.18	542.76
15.00	120.00	30.00	9.00	4.00	180.00	11.85	546.97
15.00	120.00	30.00	9.00	7.00	180.00	11.85	546.97
15.00	120.00	30.00	9.00	10.00	180.00	11.85	546.97
15.00	120.00	30.00	16.00	1.00	176.46	18.18	909.70
15.00	120.00	30.00	16.00	4.00	180.00	18.85	913.91
15.00	120.00	30.00	16.00	7.00	180.00	18.85	913.91
15.00	120.00	30.00	16.00	10.00	180.00	18.85	913.91
15.00	120.00	30.00	22.00	1.00	176.46	24.18	1224.23
15.00	120.00	30.00	22.00	4.00	180.00	24.85	1228.43
15.00	120.00	30.00	22.00	7.00	180.00	24.85	1228.43
15.00	120.00	30.00	22.00	10.00	180.00	24.85	1228.43

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
15.00	120.00	20.00	2.50	1.00	174.45	5.35	233.90
15.00	120.00	20.00	2.50	4.00	179.17	6.78	249.95
15.00	120.00	20.00	2.50	7.00	180.00	7.02	250.32
15.00	120.00	20.00	2.50	10.00	180.00	7.02	250.32
15.00	120.00	20.00	9.00	1.00	174.45	11.85	574.64
15.00	120.00	20.00	9.00	4.00	179.17	13.28	590.68
15.00	120.00	20.00	9.00	7.00	180.00	13.52	591.05
15.00	120.00	20.00	9.00	10.00	180.00	13.52	591.05
15.00	120.00	20.00	16.00	1.00	174.45	18.85	941.58
15.00	120.00	20.00	16.00	4.00	179.17	20.28	957.63
15.00	120.00	20.00	16.00	7.00	180.00	20.52	957.99
15.00	120.00	20.00	16.00	10.00	180.00	20.52	957.99
15.00	120.00	20.00	22.00	1.00	174.45	24.85	1256.10
15.00	120.00	20.00	22.00	4.00	179.17	26.28	1272.15
15.00	120.00	20.00	22.00	7.00	180.00	26.52	1272.51
15.00	120.00	20.00	22.00	10.00	180.00	26.52	1272.51
15.00	120.00	10.00	2.50	1.00	171.28	6.41	293.66
15.00	120.00	10.00	2.50	4.00	174.41	8.36	342.94
15.00	120.00	10.00	2.50	7.00	177.55	10.32	370.65
15.00	120.00	10.00	2.50	10.00	180.00	11.84	377.23
15.00	120.00	10.00	9.00	1.00	171.28	12.91	634.39
15.00	120.00	10.00	9.00	4.00	174.41	14.86	683.67
15.00	120.00	10.00	9.00	7.00	177.55	16.82	711.38
15.00	120.00	10.00	9.00	10.00	180.00	18.34	717.97
15.00	120.00	10.00	16.00	1.00	171.28	19.91	1001.33
15.00	120.00	10.00	16.00	4.00	174.41	21.86	1050.61
15.00	120.00	10.00	16.00	7.00	177.55	23.82	1078.32
15.00	120.00	10.00	16.00	10.00	180.00	25.34	1084.91
15.00	120.00	10.00	22.00	1.00	171.28	25.91	1315.85
15.00	120.00	10.00	22.00	4.00	174.41	27.86	1365.13
15.00	120.00	10.00	22.00	7.00	177.55	29.82	1392.84
15.00	120.00	10.00	22.00	10.00	180.00	31.34	1399.43

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
15.00	140.00	40.00	2.50	1.00	177.35	4.38	221.09
15.00	140.00	40.00	2.50	4.00	180.00	4.79	223.31
15.00	140.00	40.00	2.50	7.00	180.00	4.79	223.31
15.00	140.00	40.00	2.50	10.00	180.00	4.79	223.31
15.00	140.00	40.00	9.00	1.00	177.35	10.88	618.61
15.00	140.00	40.00	9.00	4.00	180.00	11.29	620.83
15.00	140.00	40.00	9.00	7.00	180.00	11.29	620.83
15.00	140.00	40.00	9.00	10.00	180.00	11.29	620.83
15.00	140.00	40.00	16.00	1.00	177.35	17.88	1046.71
15.00	140.00	40.00	16.00	4.00	180.00	18.29	1048.93
15.00	140.00	40.00	16.00	7.00	180.00	18.29	1048.93
15.00	140.00	40.00	16.00	10.00	180.00	18.29	1048.93
15.00	140.00	40.00	22.00	1.00	177.35	23.88	1413.65
15.00	140.00	40.00	22.00	4.00	180.00	24.29	1415.87
15.00	140.00	40.00	22.00	7.00	180.00	24.29	1415.87
15.00	140.00	40.00	22.00	10.00	180.00	24.29	1415.87
15.00	140.00	30.00	2.50	1.00	175.81	4.90	247.19
15.00	140.00	30.00	2.50	4.00	180.00	5.83	255.23
15.00	140.00	30.00	2.50	7.00	180.00	5.83	255.23
15.00	140.00	30.00	2.50	10.00	180.00	5.83	255.23
15.00	140.00	30.00	9.00	1.00	175.81	11.40	644.71
15.00	140.00	30.00	9.00	4.00	180.00	12.33	652.75
15.00	140.00	30.00	9.00	7.00	180.00	12.33	652.75
15.00	140.00	30.00	9.00	10.00	180.00	12.33	652.75
15.00	140.00	30.00	16.00	1.00	175.81	18.40	1072.81
15.00	140.00	30.00	16.00	4.00	180.00	19.33	1080.85
15.00	140.00	30.00	16.00	7.00	180.00	19.33	1080.85
15.00	140.00	30.00	16.00	10.00	180.00	19.33	1080.85
15.00	140.00	30.00	22.00	1.00	175.81	24.40	1439.75
15.00	140.00	30.00	22.00	4.00	180.00	25.33	1447.79
15.00	140.00	30.00	22.00	7.00	180.00	25.33	1447.79
15.00	140.00	30.00	22.00	10.00	180.00	25.33	1447.79

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ********** PAGE = 22

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
15.00	140.00	20.00	2.50	1.00	173.76	5.58	286.97
15.00	140.00	20.00	2.50	4.00	178.13	7.12	312.70
15.00	140.00	20.00	2.50	7.00	180.00	7.78	315.22
15.00	140.00	20.00	2.50	10.00	180.00	7.78	315.22
15.00	140.00	20.00	9.00	1.00	173.76	12.08	684.49
15.00	140.00	20.00	9.00	4.00	178.13	13.62	710.22
15.00	140.00	20.00	9.00	7.00	180.00	14.28	712.75
15.00	140.00	20.00	9.00	10.00	180.00	14.28	712.75
15.00	140.00	20.00	16.00	1.00	173.76	19.08	1112.58
15.00	140.00	20.00	16.00	4.00	178.13	20.62	1138.32
15.00	140.00	20.00	16.00	7.00	180.00	21.28	1140.84
15.00	140.00	20.00	16.00	10.00	180.00	21.28	1140.84
15.00	140.00	20.00	22.00	1.00	173.76	25.08	1479.53
15.00	140.00	20.00	22.00	4.00	178.13	26.62	1505.26
15.00	140.00	20.00	22.00	7.00	180.00	27.28	1507.79
15.00	140.00	20.00	22.00	10.00	180.00	27.28	1507.79
15.00	140.00	10.00	2.50	1.00	170.66	6.61	357.66
15.00	140.00	10.00	2.50	4.00	173.49	8.67	424.63
15.00	140.00	10.00	2.50	7.00	176.32	10.73	467.74
15.00	140.00	10.00	2.50	10.00	179.15	12.78	486.91
15.00	140.00	10.00	9.00	1.00	170.66	13.11	755.18
15.00	140.00	10.00	9.00	4.00	173.49	15.17	822.15
15.00	140.00	10.00	9.00	7.00	176.32	17.23	865.26
15.00	140.00	10.00	9.00	10.00	179.15	19.28	884.43
15.00	140.00	10.00	16.00	1.00	170.66	20.11	1183.28
15.00	140.00	10.00	16.00	4.00	173.49	22.17	1250.24
15.00	140.00	10.00	16.00	7.00	176.32	24.23	1293.36
15.00	140.00	10.00	16.00	10.00	179.15	26.28	1312.53
15.00	140.00	10.00	22.00	1.00	170.66	26.11	1550.22
15.00	140.00	10.00	22.00	4.00	173.49	28.17	1617.19
15.00	140.00	10.00	22.00	7.00	176.32	30.23	1660.30
15.00	140.00	10.00	22.00	10.00	179.15	32.28	1679.47

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ********** PAGE = 23

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
15.00	160.00	40.00	2.50	1.00	176.82	4.56	262.54
15.00	160.00	40.00	2.50	4.00	180.00	5.12	266.70
15.00	160.00	40.00	2.50	7.00	180.00	5.12	266.70
15.00	160.00	40.00	2.50	10.00	180.00	5.12	266.70
15.00	160.00	40.00	9.00	1.00	176.82	11.06	716.85
15.00	160.[illegible]	40.00	9.00	4.00	180.00	11.62	721.01
15.00	160.00	40.00	9.00	7.00	180.00	11.62	721.01
15.00	160.00	40.00	9.00	10.00	180.00	11.62	721.01
15.00	160.00	40.00	16.00	1.00	176.82	18.06	1206.10
15.00	160.00	40.00	16.00	4.00	180.00	18.62	1210.27
15.00	160.00	40.00	16.00	7.00	180.00	18.62	1210.27
15.00	160.00	40.00	16.00	10.00	180.00	18.62	1210.27
15.00	160.00	40.00	22.00	1.00	176.82	24.06	1625.46
15.00	160.00	40.00	22.00	4.00	180.00	24.62	1629.63
15.00	160.00	40.00	22.00	7.00	180.00	24.62	1629.63
15.00	160.00	40.00	22.00	10.00	180.00	24.62	1629.63
15.00	160.00	30.00	2.50	1.00	175.22	5.09	294.78
15.00	160.00	30.00	2.50	4.00	180.00	6.30	308.40
15.00	160.00	30.00	2.50	7.00	180.00	6.30	308.40
15.00	160.00	30.00	2.50	10.00	180.00	6.30	308.40
15.00	160.00	30.00	9.00	1.00	175.22	11.59	749.09
15.00	160.00	30.00	9.00	4.00	180.00	12.80	762.71
15.00	160.00	30.00	9.00	7.00	180.00	12.80	762.71
15.00	160.00	30.00	9.00	10.00	180.00	12.80	762.71
15.00	160.00	30.00	16.00	1.00	175.22	18.59	1238.34
15.00	160.00	30.00	16.00	4.00	180.00	19.80	1251.96
15.00	160.00	30.00	16.00	7.00	180.00	19.80	1251.96
15.00	160.00	30.00	16.00	10.00	180.00	19.80	1251.96
15.00	160.00	30.00	22.00	1.00	175.22	24.59	1657.70
15.00	160.00	30.00	22.00	4.00	180.00	25.80	1671.33
15.00	160.00	30.00	22.00	7.00	180.00	25.80	1671.33
15.00	160.00	30.00	22.00	10.00	180.00	25.80	1671.33

********** BLUNDER ANALYSIS - DUAL AIRCRAFT [illegible] ********** [illegible] = 24

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	LUNGER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
15.00	160.00	20.00	2.50	1.00	173.16	5.78	342.44
15.00	160.00	20.00	2.50	4.00	177.24	7.42	379.52
15.00	160.00	20.00	2.50	7.00	180.00	8.53	386.76
15.00	160.00	20.00	2.50	10.00	180.00	8.53	386.76
15.00	160.00	20.00	9.00	1.00	173.16	12.28	796.75
15.00	160.00	20.00	9.00	4.00	177.24	13.92	833.83
15.00	160.00	20.00	9.00	7.00	180.00	15.03	841.07
15.00	160.00	20.00	9.00	10.00	180.00	15.03	841.07
15.00	160.00	20.00	16.00	1.00	173.16	19.28	1286.01
15.00	160.00	20.00	16.00	4.00	177.24	20.92	1323.19
15.00	160.00	20.00	16.00	7.00	180.00	22.03	1330.33
15.00	160.00	20.00	16.00	10.00	180.00	22.03	1330.33
15.00	160.00	20.00	22.00	1.00	173.16	25.28	1705.37
15.00	160.00	20.00	22.00	4.00	177.24	26.92	1742.45
15.00	160.00	20.00	22.00	7.00	180.00	28.03	1749.69
15.00	160.00	20.00	22.00	10.00	180.00	28.03	1749.69
15.00	160.00	10.00	2.50	1.00	170.16	6.78	423.32
15.00	160.00	10.00	2.50	4.00	172.74	8.92	509.29
15.00	160.00	10.00	2.50	7.00	175.31	11.06	569.46
15.00	160.00	10.00	2.50	10.00	177.89	13.20	603.71
15.00	160.00	10.00	9.00	1.00	170.16	13.28	877.63
15.00	160.00	10.00	9.00	4.00	172.74	15.42	963.60
15.00	160.00	10.00	9.00	7.00	175.31	17.56	1023.77
15.00	160.00	10.00	9.00	10.00	177.89	19.70	1058.01
15.00	160.00	10.00	16.00	1.00	170.16	20.28	1366.89
15.00	160.00	10.00	16.00	4.00	172.74	22.42	1452.86
15.00	160.00	10.00	16.00	7.00	175.31	24.56	1513.03
15.00	160.00	10.00	16.00	10.00	177.89	26.70	1547.27
15.00	160.00	10.00	22.00	1.00	170.16	26.28	1786.25
15.00	160.00	10.00	22.00	4.00	172.74	28.42	1872.22
15.00	160.00	10.00	22.00	7.00	175.31	30.56	1932.39
15.00	160.00	10.00	22.00	10.00	177.89	32.70	1966.63

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
20.00	[illegible]	40.00	2.50	1.00	179.23	3.76	109.45
20.00	[illegible]	40.00	2.50	4.00	180.00	3.81	109.48
20.00	[illegible]	40.00	2.50	7.00	180.00	3.81	109.48
20.00	[illegible]	40.00	2.50	10.00	180.00	3.81	109.48
20.00	[illegible]	40.00	9.00	1.00	179.23	10.26	334.58
20.00	[illegible]	40.00	9.00	4.00	180.00	10.31	334.61
20.00	[illegible]	40.00	9.00	7.00	180.00	10.31	334.61
20.00	[illegible]	40.00	9.00	10.00	180.00	10.31	334.61
20.00	[illegible]	40.00	16.00	1.00	179.23	17.26	577.03
20.00	[illegible]	40.00	16.00	4.00	180.00	17.31	577.06
20.00	[illegible]	40.00	16.00	7.00	180.00	17.31	577.06
20.00	[illegible]	40.00	16.00	10.00	180.00	17.31	577.06
20.00	[illegible]	40.00	22.00	1.00	179.23	23.26	784.84
20.00	[illegible]	40.00	22.00	4.00	180.00	23.31	784.88
20.00	[illegible]	40.00	22.00	7.00	180.00	23.31	784.88
20.00	[illegible]	40.00	22.00	10.00	180.00	23.31	784.88
20.00	[illegible]	30.00	2.50	1.00	177.90	4.20	119.49
20.00	[illegible]	30.00	2.50	4.00	180.00	4.40	119.86
20.00	[illegible]	30.00	2.50	7.00	180.00	4.40	119.86
20.00	[illegible]	30.00	2.50	10.00	180.00	4.40	119.86
20.00	[illegible]	30.00	9.00	1.00	177.90	[illegible]	344.62
20.00	[illegible]	30.00	9.00	4.00	180.00	10.90	344.99
20.00	[illegible]	30.00	9.00	7.00	180.00	10.90	344.99
20.00	[illegible]	30.00	9.00	10.00	180.00	10.90	344.99
20.00	[illegible]	30.00	16.00	1.00	177.90	17.70	587.07
20.00	[illegible]	30.00	16.00	4.00	180.00	17.90	587.44
20.00	[illegible]	30.00	16.00	7.00	180.00	17.90	587.44
20.00	[illegible]	30.00	16.00	10.00	180.00	17.90	587.44
20.00	[illegible]	30.00	22.00	1.00	177.90	23.70	794.88
20.00	[illegible]	30.00	22.00	4.00	180.00	23.90	795.25
20.00	[illegible]	30.00	22.00	7.00	180.00	23.90	795.25
20.00	[illegible]	30.00	22.00	10.00	[illegible]	23.90	795.25

********** BLUNDER ANALYSIS - DUAL AIRCRAFT ALCOVER ********** PAGE = 26

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
20.00	60.00	20.00	2.50	1.00	175.84	4.89	137.05
20.00	60.00	20.00	2.50	4.00	180.00	5.52	139.36
20.00	60.00	20.00	2.50	7.00	180.00	5.52	139.36
20.00	60.00	20.00	2.50	10.00	180.00	5.52	139.36
20.00	60.00	20.00	9.00	1.00	175.84	11.39	362.18
20.00	60.00	20.00	9.00	4.00	180.00	12.02	364.49
20.00	60.00	20.00	9.00	7.00	160.00	12.02	364.49
20.00	60.00	20.00	9.00	10.00	180.00	12.02	364.49
20.00	60.00	20.00	16.00	1.00	175.84	18.39	604.63
20.00	60.00	20.00	16.00	4.00	180.00	19.02	606.94
20.00	60.00	20.00	16.00	7.00	180.00	19.02	606.94
20.00	60.00	20.00	16.00	10.00	180.00	19.02	606.94
20.00	60.00	20.00	22.00	1.00	175.84	24.39	812.45
20.00	60.00	20.00	22.00	4.00	180.00	25.02	814.76
20.00	60.00	20.00	22.00	7.00	180.00	25.02	814.76
20.00	60.00	20.00	22.00	10.00	180.00	25.02	814.76
20.00	60.00	10.00	2.50	1.00	171.89	6.20	177.47
20.00	60.00	10.00	2.50	4.00	176.55	7.65	192.24
20.00	60.00	10.00	2.50	7.00	180.00	8.73	195.52
20.00	60.00	10.00	2.50	10.00	180.00	8.73	195.52
20.00	60.00	10.00	9.00	1.00	171.89	12.70	402.60
20.00	60.00	10.00	9.00	4.00	176.55	14.15	417.37
20.00	60.00	10.00	9.00	7.00	180.00	15.23	420.65
20.00	60.00	10.00	9.00	10.00	180.00	15.23	420.65
20.00	60.00	10.00	16.00	1.00	171.89	19.70	645.05
20.00	60.00	10.00	16.00	4.00	176.55	21.15	659.82
20.00	60.00	10.00	16.00	7.00	180.00	22.23	663.10
20.00	60.00	10.00	16.00	10.00	180.00	22.23	663.10
20.00	60.00	10.00	22.00	1.00	171.89	25.70	852.57
20.00	60.00	10.00	22.00	4.00	176.55	27.15	867.64
20.00	60.00	10.00	22.00	7.00	180.00	28.23	870.92
20.00	60.00	10.00	22.00	10.00	180.00	28.23	870.92

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ********** PAGE = 27

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
20.00	80.00	40.00	2.50	1.00	178.23	4.09	155.82
20.00	80.00	40.00	2.50	4.00	180.00	4.24	156.15
20.00	80.00	40.00	2.50	7.00	180.00	4.24	156.15
20.00	80.00	40.00	2.50	10.00	180.00	4.24	156.15
20.00	80.00	40.00	9.00	1.00	178.23	10.59	456.00
20.00	80.00	40.00	9.00	4.00	180.00	10.74	456.32
20.00	80.00	40.00	9.00	7.00	180.00	10.74	456.32
20.00	80.00	40.00	9.00	10.00	180.00	10.74	456.32
20.00	80.00	40.00	16.00	1.00	178.23	17.59	779.27
20.00	80.00	40.00	16.00	4.00	180.00	17.74	779.59
20.00	80.00	40.00	16.00	7.00	180.00	17.74	779.59
20.00	80.00	40.00	16.00	10.00	180.00	17.74	779.59
20.00	80.00	40.00	22.00	1.00	178.23	23.59	1056.35
20.00	80.00	40.00	22.00	4.00	180.00	23.74	1056.68
20.00	80.00	40.00	22.00	7.00	180.00	23.74	1056.68
20.00	80.00	40.00	22.00	10.00	180.00	23.74	1056.68
20.00	80.00	30.00	2.50	1.00	176.66	4.61	172.93
20.00	80.00	30.00	2.50	4.00	180.00	5.04	174.60
20.00	80.00	30.00	2.50	7.00	180.00	5.04	174.60
20.00	80.00	30.00	2.50	10.00	180.00	5.04	174.60
20.00	80.00	30.00	9.00	1.00	176.66	11.11	473.11
20.00	80.00	30.00	9.00	4.00	180.00	11.54	474.77
20.00	80.00	30.00	9.00	7.00	180.00	11.54	474.77
20.00	80.00	30.00	9.00	10.00	180.00	11.54	474.77
20.00	80.00	30.00	16.00	1.00	176.66	18.11	796.38
20.00	80.00	30.00	16.00	4.00	180.00	18.54	798.04
20.00	80.00	30.00	16.00	7.00	180.00	18.54	798.04
20.00	80.00	30.00	16.00	10.00	180.00	18.54	798.04
20.00	80.00	30.00	22.00	1.00	176.66	24.11	1073.46
20.00	80.00	30.00	22.00	4.00	180.00	24.54	1075.13
20.00	80.00	30.00	22.00	7.00	180.00	24.54	1075.13
20.00	80.00	30.00	22.00	10.00	180.00	24.54	1075.13

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERER VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
20.00	[illegible]	20.00	2.50	1.00	174.35	5.38	201.70
20.00	[illegible]	20.00	2.50	4.00	179.96	5.51	209.27
20.00	[illegible]	20.00	2.50	7.00	180.00	6.52	209.27
20.00	[illegible]	20.00	2.50	10.00	180.00	6.52	209.27
20.00	[illegible]	20.00	9.00	1.00	174.35	11.88	501.88
20.00	[illegible]	20.00	9.00	4.00	179.96	13.01	509.44
20.00	[illegible]	20.00	9.00	7.00	180.00	13.02	509.44
20.00	[illegible]	20.00	9.00	10.00	180.00	13.02	509.44
20.00	[illegible]	20.00	16.00	1.00	174.35	18.88	825.14
20.00	[illegible]	20.00	16.00	4.00	179.96	20.01	832.71
20.00	[illegible]	20.00	16.00	7.00	180.00	20.02	832.71
20.00	[illegible]	20.00	16.00	10.00	180.00	20.02	832.71
20.00	[illegible]	20.00	22.00	1.00	174.35	24.88	1102.23
20.00	[illegible]	20.00	22.00	4.00	179.96	26.01	1109.80
20.00	[illegible]	20.00	22.00	7.00	180.00	26.02	1109.80
20.00	[illegible]	20.00	22.00	10.00	180.00	26.02	1109.80
20.00	[illegible]	10.00	2.50	1.00	170.24	6.75	262.67
20.00	[illegible]	10.00	2.50	4.00	174.25	8.42	292.96
20.00	[illegible]	10.00	2.50	7.00	178.26	10.08	307.63
20.00	[illegible]	10.00	2.50	10.00	180.00	10.80	309.10
20.00	[illegible]	10.00	9.00	1.00	170.24	13.25	562.64
20.00	[illegible]	10.00	9.00	4.00	174.25	14.92	593.14
20.00	[illegible]	10.00	9.00	7.00	178.26	16.58	607.80
20.00	[illegible]	10.00	9.00	10.00	180.00	17.30	609.28
20.00	[illegible]	10.00	16.00	1.00	170.24	20.25	886.11
20.00	[illegible]	10.00	16.00	4.00	174.25	21.92	916.41
20.00	[illegible]	10.00	16.00	7.00	178.26	23.58	931.07
20.00	[illegible]	10.00	16.00	10.00	180.00	24.30	932.55
20.00	[illegible]	10.00	22.00	1.00	170.24	26.25	1163.29
20.00	[illegible]	10.00	22.00	4.00	174.25	27.92	1193.49
20.00	[illegible]	10.00	22.00	7.00	178.26	29.58	1208.16
20.00	[illegible]	10.00	22.00	10.00	180.00	30.30	1209.63

********* BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ********** PAGE = 29

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
20.00	100.00	40.00	2.50	1.00	177.33	4.39	206.76
20.00	100.00	40.00	2.50	4.00	180.00	4.68	207.90
20.00	100.00	40.00	2.50	7.00	180.00	4.68	207.90
20.00	100.00	40.00	2.50	10.00	180.00	4.68	207.90
20.00	100.00	40.00	9.00	1.00	177.33	10.89	581.98
20.00	100.00	40.00	9.00	4.00	180.00	11.18	583.12
20.00	100.00	40.00	9.00	7.00	180.00	11.18	583.12
20.00	100.00	40.00	9.00	10.00	180.00	11.18	583.12
20.00	100.00	40.00	16.00	1.00	177.33	17.89	986.06
20.00	100.00	40.00	16.00	4.00	180.00	18.18	987.20
20.00	100.00	40.00	16.00	7.00	180.00	18.18	987.20
20.00	100.00	40.00	16.00	10.00	180.00	18.18	987.20
20.00	100.00	40.00	22.00	1.00	177.33	23.89	1332.42
20.00	100.00	40.00	22.00	4.00	180.00	24.18	1333.56
20.00	100.00	40.00	22.00	7.00	180.00	24.18	1333.56
20.00	100.00	40.00	22.00	10.00	180.00	24.18	1333.56
20.00	100.00	30.00	2.50	1.00	175.59	4.97	232.19
20.00	100.00	30.00	2.50	4.00	180.00	5.67	236.73
20.00	100.00	30.00	2.50	7.00	180.00	5.67	236.73
20.00	100.00	30.00	2.50	10.00	180.00	5.67	236.73
20.00	100.00	30.00	9.00	1.00	175.59	11.47	607.41
20.00	100.00	30.00	9.00	4.00	180.00	12.17	611.95
20.00	100.00	30.00	9.00	7.00	180.00	12.17	611.95
20.00	100.00	30.00	9.00	10.00	180.00	12.17	611.95
20.00	100.00	30.00	16.00	1.00	175.59	18.47	1011.49
20.00	100.00	30.00	16.00	4.00	180.00	19.17	1016.03
20.00	100.00	30.00	16.00	7.00	180.00	19.17	1016.03
20.00	100.00	30.00	16.00	10.00	180.00	19.17	1016.03
20.00	100.00	30.00	22.00	1.00	175.59	24.47	1357.85
20.00	100.00	30.00	22.00	4.00	180.00	25.17	1362.39
20.00	100.00	30.00	22.00	7.00	180.00	25.17	1362.39
20.00	100.00	30.00	22.00	10.00	180.00	25.17	1362.39

********** BLUNDER ANALYSIS - DUAL AIRCRAFT ARRIVE ********** PAGE = 30

BLUNDER DEVIATION ANGLE (DEG.)	BLUNDERER VELOCITY (KNOTS)	BLUNDERER BANK ANGLE (DEG.)	BLUNDERED SIGNAL DELAYS (SEC.)	ADJACENT SIGNAL DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
20.00	[illegible]	20.00	2.50	1.00	173.11	5.80	273.36
20.00	[illegible]	20.00	2.50	4.00	175.24	7.09	289.76
20.00	[illegible]	20.00	2.50	7.00	180.00	7.53	290.90
20.00	[illegible]	20.00	2.50	10.00	180.00	7.53	290.90
20.00	[illegible]	20.00	9.00	1.00	173.11	12.30	646.58
20.00	[illegible]	20.00	9.00	4.00	178.24	13.59	664.98
20.00	[illegible]	20.00	9.00	7.00	180.00	14.03	666.12
20.00	[illegible]	20.00	9.00	10.00	180.00	14.03	666.12
20.00	[illegible]	20.00	16.00	1.00	173.11	19.30	1052.67
20.00	[illegible]	20.00	16.00	4.00	178.24	20.59	1069.06
20.00	[illegible]	20.00	16.00	7.00	180.00	21.03	1070.21
20.00	[illegible]	20.00	16.00	10.00	180.00	21.03	1070.21
20.00	[illegible]	20.00	22.00	1.00	173.11	25.36	1399.02
20.00	[illegible]	20.00	22.00	4.00	178.24	26.59	1415.42
20.00	[illegible]	20.00	22.00	7.00	180.00	27.03	1416.56
20.00	[illegible]	20.00	22.00	10.00	180.00	27.03	1416.56
20.00	[illegible]	10.00	2.50	1.00	169.00	7.17	354.66
20.00	[illegible]	10.00	2.50	4.00	172.52	8.99	404.17
20.00	[illegible]	10.00	2.50	7.00	176.04	10.62	434.90
20.00	[illegible]	10.00	2.50	10.00	179.56	12.65	446.75
20.00	[illegible]	10.00	9.00	1.00	169.00	13.67	729.88
20.00	[illegible]	10.00	9.00	4.00	172.52	15.49	779.39
20.00	[illegible]	10.00	9.00	7.00	176.04	17.32	810.12
20.00	[illegible]	10.00	9.00	10.00	179.56	19.15	821.97
20.00	[illegible]	10.00	16.00	1.00	169.00	20.67	1133.96
20.00	[illegible]	10.00	16.00	4.00	172.52	22.49	1183.47
20.00	[illegible]	10.00	16.00	7.00	176.04	24.32	1214.21
20.00	[illegible]	10.00	16.00	10.00	179.56	26.15	1226.05
20.00	[illegible]	10.00	22.00	1.00	169.00	26.67	1480.32
20.00	[illegible]	10.00	22.00	4.00	172.52	28.49	1529.83
20.00	[illegible]	10.00	22.00	7.00	176.04	30.32	1560.57
20.00	[illegible]	10.00	22.00	10.00	179.56	32.15	1572.41

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
20.00	120.00	40.00	2.50	1.00	176.52	4.66	261.94
20.00	120.00	40.00	2.50	4.00	180.00	5.12	264.74
20.00	120.00	40.00	2.50	7.00	180.00	5.12	264.74
20.00	120.00	40.00	2.50	10.00	180.00	5.12	264.74
20.00	120.00	40.00	9.00	1.00	176.52	11.16	712.20
20.00	120.00	40.00	9.00	4.00	180.00	11.62	715.00
20.00	120.00	40.00	9.00	7.00	180.00	11.62	715.00
20.00	120.00	40.00	9.00	10.00	180.00	11.62	715.00
20.00	120.00	40.00	16.00	1.00	176.52	18.16	1197.10
20.00	120.00	40.00	16.00	4.00	180.00	18.62	1199.91
20.00	120.00	40.00	16.00	7.00	180.00	18.62	1199.91
20.00	120.00	40.00	16.00	10.00	180.00	18.62	1199.91
20.00	120.00	40.00	22.00	1.00	176.52	24.16	1612.73
20.00	120.00	40.00	22.00	4.00	180.00	24.62	1615.53
20.00	120.00	40.00	22.00	7.00	180.00	24.62	1615.53
20.00	120.00	40.00	22.00	10.00	180.00	24.62	1615.53
20.00	120.00	30.00	2.50	1.00	174.65	5.28	296.62
20.00	120.00	30.00	2.50	4.00	180.00	6.30	306.25
20.00	120.00	30.00	2.50	7.00	180.00	6.30	306.25
20.00	120.00	30.00	2.50	10.00	180.00	6.30	306.25
20.00	120.00	30.00	9.00	1.00	174.65	11.78	746.89
20.00	120.00	30.00	9.00	4.00	180.00	12.80	756.51
20.00	120.00	30.00	9.00	7.00	180.00	12.80	756.51
20.00	120.00	30.00	9.00	10.00	180.00	12.80	756.51
20.00	120.00	30.00	16.00	1.00	174.65	18.78	1231.79
20.00	120.00	30.00	16.00	4.00	180.00	19.80	1241.42
20.00	120.00	30.00	16.00	7.00	180.00	19.80	1241.42
20.00	120.00	30.00	16.00	10.00	180.00	19.80	1241.42
20.00	120.00	30.00	22.00	1.00	174.65	24.78	1647.42
20.00	120.00	30.00	22.00	4.00	180.00	25.80	1657.04
20.00	120.00	30.00	22.00	7.00	180.00	25.80	1657.04
20.00	120.00	30.00	22.00	10.00	180.00	25.80	1657.04

********** BLUNDER ANALYSIS - DUAL AIRCRAFT [illegible] ********** PAGE = 32

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
20.00	120.00	20.00	2.50	1.00	172.07	6.14	350.83
20.00	120.00	20.00	2.50	4.00	176.80	7.57	378.80
20.00	120.00	20.00	2.50	7.00	180.00	8.53	384.26
20.00	120.00	20.00	2.50	10.00	180.00	8.53	384.26
20.00	120.00	20.00	9.00	1.00	172.07	12.64	801.09
20.00	120.00	20.00	9.00	4.00	176.80	14.07	829.07
20.00	120.00	20.00	9.00	7.00	180.00	15.03	834.53
20.00	120.00	20.00	9.00	10.00	180.00	15.03	834.53
20.00	120.00	20.00	16.00	1.00	172.07	19.64	1286.00
20.00	120.00	20.00	16.00	4.00	176.80	21.07	1313.97
20.00	120.00	20.00	16.00	7.00	180.00	22.03	1319.43
20.00	120.00	20.00	16.00	10.00	180.00	22.03	1319.43
20.00	120.00	20.00	22.00	1.00	172.07	25.64	1701.62
20.00	120.00	20.00	22.00	4.00	176.80	27.07	1729.60
20.00	120.00	20.00	22.00	7.00	180.00	28.03	1735.06
20.00	120.00	20.00	22.00	10.00	180.00	28.03	1735.06
20.00	120.00	10.00	2.50	1.00	168.02	7.49	451.54
20.00	120.00	10.00	2.50	4.00	171.16	9.45	523.04
20.00	120.00	10.00	2.50	7.00	174.30	11.40	573.13
20.00	120.00	10.00	2.50	10.00	177.44	13.35	601.66
20.00	120.00	10.00	9.00	1.00	168.02	13.99	901.80
20.00	120.00	10.00	9.00	4.00	171.16	15.95	973.31
20.00	120.00	10.00	9.00	7.00	174.30	17.90	1023.40
20.00	120.00	10.00	9.00	10.00	177.44	19.85	1051.92
20.00	120.00	10.00	16.00	1.00	168.02	20.99	1386.71
20.00	120.00	10.00	16.00	4.00	171.16	22.95	1458.21
20.00	120.00	10.00	16.00	7.00	174.30	24.90	1508.30
20.00	120.00	10.00	16.00	10.00	177.44	26.85	1536.82
20.00	120.00	10.00	22.00	1.00	168.02	26.99	1802.33
20.00	120.00	10.00	22.00	4.00	171.16	28.95	1873.84
20.00	120.00	10.00	22.00	7.00	174.30	30.90	1923.93
20.00	120.00	10.00	22.00	10.00	177.44	32.85	1952.45

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER **********

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
20.00	140.00	40.00	2.50	1.00	175.78	4.91	321.05
20.00	140.00	40.00	2.50	4.00	180.00	5.55	326.67
20.00	140.00	40.00	2.50	7.00	180.00	5.55	326.67
20.00	140.00	40.00	2.50	10.00	180.00	5.55	326.67
20.00	140.00	40.00	9.00	1.00	175.78	11.41	846.36
20.00	140.00	40.00	9.00	4.00	180.00	12.05	851.98
20.00	140.00	40.00	9.00	7.00	180.00	12.05	851.98
20.00	140.00	40.00	9.00	10.00	180.00	12.05	851.98
20.00	140.00	40.00	16.00	1.00	175.78	18.41	1412.08
20.00	140.00	40.00	16.00	4.00	180.00	19.05	1417.69
20.00	140.00	40.00	16.00	7.00	180.00	19.05	1417.69
20.00	140.00	40.00	16.00	10.00	180.00	19.05	1417.69
20.00	140.00	40.00	22.00	1.00	175.78	24.41	1896.98
20.00	140.00	40.00	22.00	4.00	180.00	25.05	1902.59
20.00	140.00	40.00	22.00	7.00	180.00	25.05	1902.59
20.00	140.00	40.00	22.00	10.00	180.00	25.05	1902.59
20.00	140.00	30.00	2.50	1.00	173.81	5.56	365.65
20.00	140.00	30.00	2.50	4.00	179.21	6.76	382.88
20.00	140.00	30.00	2.50	7.00	180.00	6.94	383.17
20.00	140.00	30.00	2.50	10.00	180.00	6.94	383.17
20.00	140.00	30.00	9.00	1.00	173.81	12.06	890.96
20.00	140.00	30.00	9.00	4.00	179.21	13.26	908.19
20.00	140.00	30.00	9.00	7.00	180.00	13.44	908.48
20.00	140.00	30.00	9.00	10.00	180.00	13.44	908.48
20.00	140.00	30.00	16.00	1.00	173.81	19.06	1456.68
20.00	140.00	30.00	16.00	4.00	179.21	20.26	1473.91
20.00	140.00	30.00	16.00	7.00	180.00	20.44	1474.19
20.00	140.00	30.00	16.00	10.00	180.00	20.44	1474.19
20.00	140.00	30.00	22.00	1.00	173.81	25.06	1941.58
20.00	140.00	30.00	22.00	4.00	179.21	26.26	1958.81
20.00	140.00	30.00	22.00	7.00	180.00	26.44	1959.09
20.00	140.00	30.00	22.00	10.00	180.00	26.44	1959.09

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ********** PAGE = 34

BLUNDER DEPARTURE ANGLE (DEG.)	BLUNDERER VELOCITY (KNOTS)	BLUNDERER BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
20.00	140.00	20.00	2.50	1.00	171.19	6.44	433.13
20.00	140.00	20.00	2.50	4.00	175.57	7.98	475.10
20.00	140.00	20.00	2.50	7.00	179.94	9.52	489.35
20.00	140.00	20.00	2.50	10.00	180.00	9.54	489.35
20.00	140.00	20.00	9.00	1.00	171.19	12.94	956.43
20.00	140.00	20.00	9.00	4.00	175.57	14.48	1000.41
20.00	140.00	20.00	9.00	7.00	179.94	16.02	1014.66
20.00	140.00	20.00	9.00	10.00	180.00	16.04	1014.66
20.00	140.00	20.00	16.00	1.00	171.19	19.94	1524.15
20.00	140.00	20.00	16.00	4.00	175.57	21.48	1566.12
20.00	140.00	20.00	16.00	7.00	179.94	23.02	1580.38
20.00	140.00	20.00	16.00	10.00	180.00	23.04	1580.38
20.00	140.00	20.00	22.00	1.00	171.19	25.94	2009.05
20.00	140.00	20.00	22.00	4.00	175.57	27.46	2051.02
20.00	140.00	20.00	22.00	7.00	179.94	29.02	2065.28
20.00	140.00	20.00	22.00	10.00	180.00	29.04	2065.28
20.00	140.00	10.00	2.50	1.00	167.23	7.76	552.04
20.00	140.00	10.00	2.50	4.00	170.07	9.81	647.65
20.00	140.00	10.00	2.50	7.00	172.90	11.87	719.62
20.00	140.00	10.00	2.50	10.00	175.73	13.92	767.78
20.00	140.00	10.00	9.00	1.00	167.23	14.26	1077.35
20.00	140.00	10.00	9.00	4.00	170.07	16.31	1172.96
20.00	140.00	10.00	9.00	7.00	172.90	18.37	1244.93
20.00	140.00	10.00	9.00	10.00	175.73	20.42	1293.08
20.00	140.00	10.00	16.00	1.00	167.23	21.26	1643.07
20.00	140.00	10.00	16.00	4.00	170.07	23.31	1738.68
20.00	140.00	10.00	16.00	7.00	172.90	25.37	1810.65
20.00	140.00	10.00	16.00	10.00	175.73	27.42	1858.80
20.00	140.00	10.00	22.00	1.00	167.23	27.26	2127.97
20.00	140.00	10.00	22.00	4.00	170.07	29.31	2223.58
20.00	140.00	10.00	22.00	7.00	172.90	31.37	2295.55
20.00	140.00	10.00	22.00	10.00	175.73	33.42	2343.70

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER **********

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
20.00	160.00	40.00	2.50	1.00	175.10	5.13	383.81
20.00	160.00	40.00	2.50	4.00	180.00	5.99	393.68
20.00	160.00	40.00	2.50	7.00	180.00	5.99	393.68
20.00	160.00	40.00	2.50	10.00	180.00	5.99	393.68
20.00	160.00	40.00	9.00	1.00	175.10	11.63	984.16
20.00	160.00	40.00	9.00	4.00	180.00	12.49	994.03
20.00	160.00	40.00	9.00	7.00	180.00	12.49	994.03
20.00	160.00	40.00	9.00	10.00	180.00	12.49	994.03
20.00	160.00	40.00	16.00	1.00	175.10	18.63	1630.70
20.00	160.00	40.00	16.00	4.00	180.00	19.49	1640.57
20.00	160.00	40.00	16.00	7.00	180.00	19.49	1640.57
20.00	160.00	40.00	16.00	10.00	180.00	19.49	1640.57
20.00	160.00	40.00	22.00	1.00	175.10	24.63	2184.87
20.00	160.00	40.00	22.00	4.00	180.00	25.49	2194.74
20.00	160.00	40.00	22.00	7.00	180.00	25.49	2194.74
20.00	160.00	40.00	22.00	10.00	180.00	25.49	2194.74
20.00	160.00	30.00	2.50	1.00	173.06	5.81	438.77
20.00	160.00	30.00	2.50	4.00	178.18	7.11	465.49
20.00	160.00	30.00	2.50	7.00	180.00	7.57	467.48
20.00	160.00	30.00	2.50	10.00	180.00	7.57	467.48
20.00	160.00	30.00	9.00	1.00	173.06	12.31	1039.12
20.00	160.00	30.00	9.00	4.00	178.18	13.61	1065.84
20.00	160.00	30.00	9.00	7.00	180.00	14.07	1067.83
20.00	160.00	30.00	9.00	10.00	180.00	14.07	1067.83
20.00	160.00	30.00	16.00	1.00	173.06	19.31	1685.65
20.00	160.00	30.00	16.00	4.00	178.18	20.61	1712.38
20.00	160.00	30.00	16.00	7.00	180.00	21.07	1714.36
20.00	160.00	30.00	16.00	10.00	180.00	21.07	1714.36
20.00	160.00	30.00	22.00	1.00	173.06	25.31	2239.83
20.00	160.00	30.00	22.00	4.00	178.18	26.61	2266.55
20.00	160.00	30.00	22.00	7.00	180.00	27.07	2266.54
20.00	160.00	30.00	22.00	10.00	180.00	27.07	2268.54

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED HALF ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
20.00	160.00	20.00	2.50	1.00	170.42	6.69	519.46
20.00	160.00	20.00	2.50	4.00	174.50	8.33	577.55
20.00	160.00	20.00	2.50	7.00	178.58	9.97	604.26
20.00	160.00	20.00	2.50	10.00	180.00	10.54	606.17
20.00	160.00	20.00	9.00	1.00	170.42	13.19	1119.81
20.00	160.00	20.00	9.00	4.00	174.50	14.83	1177.90
20.00	160.00	20.00	9.00	7.00	178.58	16.47	1204.61
20.00	160.00	20.00	9.00	10.00	180.00	17.04	1206.52
20.00	160.00	20.00	16.00	1.00	170.42	20.19	1766.35
20.00	160.00	20.00	16.00	4.00	174.50	21.83	1824.44
20.00	160.00	20.00	16.00	7.00	178.58	23.47	1851.15
20.00	160.00	20.00	16.00	10.00	180.00	24.04	1853.05
20.00	160.00	20.00	22.00	1.00	170.42	26.19	2320.52
20.00	160.00	20.00	22.00	4.00	174.50	27.83	2378.61
20.00	160.00	20.00	22.00	7.00	178.56	29.47	2405.32
20.00	160.00	20.00	22.00	10.00	180.00	30.04	2407.23
20.00	160.00	10.00	2.50	1.00	166.59	7.97	655.29
20.00	160.00	10.00	2.50	4.00	169.17	10.11	776.66
20.00	160.00	10.00	2.50	7.00	171.75	12.25	872.48
20.00	160.00	10.00	2.50	10.00	174.33	14.39	942.56
20.00	160.00	10.00	9.00	1.00	166.59	14.47	1255.65
20.00	160.00	10.00	9.00	4.00	169.17	16.61	1377.01
20.00	160.00	10.00	9.00	7.00	171.75	18.75	1472.83
20.00	160.00	10.00	9.00	10.00	174.33	20.89	1542.91
20.00	160.00	10.00	16.00	1.00	166.59	21.47	1902.18
20.00	160.00	10.00	16.00	4.00	169.17	23.61	2023.55
20.00	160.00	10.00	16.00	7.00	171.75	25.75	2119.37
20.00	160.00	10.00	16.00	10.00	174.33	27.89	2189.45
20.00	160.00	10.00	22.00	1.00	166.59	27.47	2456.35
20.00	160.00	10.00	22.00	4.00	169.17	29.61	2577.72
20.00	160.00	10.00	22.00	7.00	171.75	31.75	2673.54
20.00	160.00	10.00	22.00	10.00	174.33	33.89	2743.62

********** BLUNDER ANALYSIS - DUAL AIRCRAFT [illegible] ********** PAGE = 37

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
30.00	60.00	40.00	2.50	1.00	177.59	4.30	177.10
30.00	60.00	40.00	2.50	4.00	180.00	4.46	177.44
30.00	60.00	40.00	2.50	7.00	180.00	4.46	177.44
30.00	60.00	40.00	2.50	10.00	180.00	4.46	177.44
30.00	60.00	40.00	9.00	1.00	177.59	10.60	506.22
30.00	60.00	40.00	9.00	4.00	180.00	10.96	506.56
30.00	60.00	40.00	9.00	7.00	180.00	10.96	506.56
30.00	60.00	40.00	9.00	10.00	180.00	10.96	506.56
30.00	60.00	40.00	16.00	1.00	177.59	17.80	860.66
30.00	60.00	40.00	16.00	4.00	180.00	17.96	861.00
30.00	60.00	40.00	16.00	7.00	180.00	17.96	861.00
30.00	60.00	40.00	16.00	10.00	180.00	17.96	861.00
30.00	60.00	40.00	22.00	1.00	177.59	23.80	1164.46
30.00	60.00	40.00	22.00	4.00	180.00	23.96	1164.80
30.00	60.00	40.00	22.00	7.00	180.00	23.96	1164.80
30.00	60.00	40.00	22.00	10.00	180.00	23.96	1164.80
30.00	60.00	30.00	2.50	1.00	175.66	4.94	198.92
30.00	60.00	30.00	2.50	4.00	180.00	5.35	200.49
30.00	60.00	30.00	2.50	7.00	180.00	5.35	200.49
30.00	60.00	30.00	2.50	10.00	180.00	5.35	200.49
30.00	60.00	30.00	9.00	1.00	175.68	11.44	528.04
30.00	60.00	30.00	9.00	4.00	180.00	11.85	529.61
30.00	60.00	30.00	9.00	7.00	180.00	11.85	529.61
30.00	60.00	30.00	9.00	10.00	180.00	11.85	529.61
30.00	60.00	30.00	16.00	1.00	175.68	18.44	882.48
30.00	60.00	30.00	16.00	4.00	180.00	18.85	884.05
30.00	60.00	30.00	16.00	7.00	180.00	18.85	884.05
30.00	60.00	30.00	16.00	10.00	180.00	18.85	884.05
30.00	60.00	30.00	22.00	1.00	175.68	24.44	1186.29
30.00	60.00	30.00	22.00	4.00	180.00	24.85	1187.86
30.00	60.00	30.00	22.00	7.00	180.00	24.85	1187.36
30.00	60.00	30.00	22.00	10.00	180.00	24.85	1187.36

********** BLUNDER ANALYSIS - DUAL AIRCRAFT AI-OVER ********** PAGE = 38

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
30.00	60.00	20.00	2.50	1.00	172.72	5.93	236.77
30.00	60.00	20.00	2.50	4.00	178.92	6.86	243.66
30.00	60.00	20.00	2.50	7.00	180.00	7.02	243.82
30.00	60.00	20.00	2.50	10.00	180.00	7.02	243.82
30.00	60.00	20.00	9.00	1.00	172.72	12.43	565.89
30.00	60.00	20.00	9.00	4.00	178.92	13.36	572.78
30.00	60.00	20.00	9.00	7.00	180.00	13.52	572.94
30.00	60.00	20.00	9.00	10.00	180.00	13.52	572.94
30.00	60.00	20.00	16.00	1.00	172.72	19.43	920.33
30.00	60.00	20.00	16.00	4.00	178.92	20.36	927.22
30.00	60.00	20.00	16.00	7.00	180.00	20.52	927.38
30.00	60.00	20.00	16.00	10.00	180.00	20.52	927.38
30.00	60.00	20.00	22.00	1.00	172.72	25.43	1224.13
30.00	60.00	20.00	22.00	4.00	178.92	26.36	1231.03
30.00	60.00	20.00	22.00	7.00	180.00	26.52	1231.18
30.00	60.00	20.00	22.00	10.00	180.00	26.52	1231.18
30.00	60.00	10.00	2.50	1.00	167.06	7.81	322.73
30.00	60.00	10.00	2.50	4.00	171.72	9.26	349.74
30.00	60.00	10.00	2.50	7.00	176.37	10.71	364.95
30.00	60.00	10.00	2.50	10.00	180.00	11.84	368.57
30.00	60.00	10.00	9.00	1.00	167.06	14.31	651.86
30.00	60.00	10.00	9.00	4.00	171.72	15.76	678.86
30.00	60.00	10.00	9.00	7.00	176.37	17.21	694.08
30.00	60.00	10.00	9.00	10.00	180.00	18.34	697.70
30.00	60.00	10.00	16.00	1.00	167.06	21.31	1006.29
30.00	60.00	10.00	16.00	4.00	171.72	22.76	1033.30
30.00	60.00	10.00	16.00	7.00	176.37	24.21	1048.51
30.00	60.00	10.00	16.00	10.00	180.00	25.34	1052.13
30.00	60.00	10.00	22.00	1.00	167.06	27.31	1310.10
30.00	60.00	10.00	22.00	4.00	171.72	28.76	1337.10
30.00	60.00	10.00	22.00	7.00	176.37	30.21	1352.32
30.00	60.00	10.00	22.00	10.00	180.00	31.34	1355.94

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ********** PAGE = 39

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
30.00	80.00	40.00	2.50	1.00	176.16	4.78	257.66
30.00	80.00	40.00	2.50	4.00	180.00	5.12	259.18
30.00	80.00	40.00	2.50	7.00	180.00	5.12	259.18
30.00	80.00	40.00	2.50	10.00	180.00	5.12	259.18
30.00	80.00	40.00	9.00	1.00	176.16	11.28	696.49
30.00	80.00	40.00	9.00	4.00	180.00	11.62	698.01
30.00	80.00	40.00	9.00	7.00	180.00	11.62	698.01
30.00	80.00	40.00	9.00	10.00	180.00	11.62	698.01
30.00	80.00	40.00	16.00	1.00	176.16	18.28	1169.08
30.00	80.00	40.00	16.00	4.00	180.00	18.62	1170.60
30.00	80.00	40.00	16.00	7.00	180.00	18.62	1170.60
30.00	80.00	40.00	16.00	10.00	180.00	18.62	1170.60
30.00	80.00	40.00	22.00	1.00	176.16	24.28	1574.15
30.00	80.00	40.00	22.00	4.00	180.00	24.62	1575.67
30.00	80.00	40.00	22.00	7.00	180.00	24.62	1575.67
30.00	80.00	40.00	22.00	10.00	180.00	24.62	1575.67
30.00	80.00	30.00	2.50	1.00	173.91	5.53	294.63
30.00	80.00	30.00	2.50	4.00	180.00	6.30	300.17
30.00	80.00	30.00	2.50	7.00	180.00	6.30	300.17
30.00	80.00	30.00	2.50	10.00	180.00	6.30	300.17
30.00	80.00	30.00	9.00	1.00	173.91	12.03	733.46
30.00	80.00	30.00	9.00	4.00	180.00	12.80	739.00
30.00	80.00	30.00	9.00	7.00	180.00	12.80	739.00
30.00	80.00	30.00	9.00	10.00	180.00	12.80	739.00
30.00	80.00	30.00	16.00	1.00	173.91	19.03	1206.04
30.00	80.00	30.00	16.00	4.00	180.00	19.80	1211.58
30.00	80.00	30.00	16.00	7.00	180.00	19.80	1211.58
30.00	80.00	30.00	16.00	10.00	180.00	19.80	1211.58
30.00	80.00	30.00	22.00	1.00	173.91	25.03	1611.12
30.00	80.00	30.00	22.00	4.00	180.00	25.80	1616.65
30.00	80.00	30.00	22.00	7.00	180.00	25.80	1616.65
30.00	80.00	30.00	22.00	10.00	180.00	25.80	1616.65

********** BLUNDER ANALYSIS - DUAL AIRCRAFT ARROVER ********** PG = 49

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
30.00	80.00	20.00	2.50	1.00	170.56	6.64	356.23
30.00	80.00	20.00	2.50	4.00	176.20	7.77	373.77
30.00	80.00	20.00	2.50	7.00	180.00	8.53	377.19
30.00	80.00	20.00	2.50	10.00	180.00	8.53	377.19
30.00	80.00	20.00	9.00	1.00	170.58	13.14	795.06
30.00	80.00	20.00	9.00	4.00	176.20	14.27	812.60
30.00	80.00	20.00	9.00	7.00	180.00	15.03	816.02
30.00	80.00	20.00	9.00	10.00	180.00	15.03	816.02
30.00	80.00	20.00	16.00	1.00	170.58	20.14	1267.65
30.00	80.00	20.00	16.00	4.00	176.20	21.27	1285.18
30.00	80.00	20.00	16.00	7.00	180.00	22.03	1288.61
30.00	80.00	20.00	16.00	10.00	180.00	22.03	1288.61
30.00	80.00	20.00	22.00	1.00	170.58	26.14	1672.72
30.00	80.00	20.00	22.00	4.00	176.20	27.27	1690.26
30.00	80.00	20.00	22.00	7.00	180.00	28.03	1693.68
30.00	80.00	20.00	22.00	10.00	180.00	28.03	1693.68
30.00	80.00	10.00	2.50	1.00	164.70	8.60	485.15
30.00	80.00	10.00	2.50	4.00	168.71	10.26	536.81
30.00	80.00	10.00	2.50	7.00	172.72	11.93	573.06
30.00	80.00	10.00	2.50	10.00	176.72	13.59	593.73
30.00	80.00	10.00	9.00	1.00	164.70	15.10	923.97
30.00	80.00	10.00	9.00	4.00	168.71	16.76	975.64
30.00	80.00	10.00	9.00	7.00	172.72	18.43	1011.89
30.00	80.00	10.00	9.00	10.00	176.72	20.09	1032.56
30.00	80.00	10.00	16.00	1.00	164.70	22.10	1396.56
30.00	80.00	10.00	16.00	4.00	168.71	23.76	1448.22
30.00	80.00	10.00	16.00	7.00	172.72	25.43	1484.48
30.00	80.00	10.00	16.00	10.00	176.72	27.09	1505.15
30.00	80.00	10.00	22.00	1.00	164.70	28.10	1801.63
30.00	80.00	10.00	22.00	4.00	168.71	29.76	1853.29
30.00	80.00	10.00	22.00	7.00	172.72	31.43	1889.55
30.00	80.00	10.00	22.00	10.00	176.72	33.09	1910.22

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
30.00	100.00	40.00	2.50	1.00	174.87	5.21	348.09
30.00	100.00	40.00	.50	4.00	180.00	5.77	352.23
30.00	100.00	40.00	.50	7.00	180.00	5.77	352.23
30.00	100.00	40.00	.50	10.00	180.00	5.77	352.23
30.00	100.00	40.00	9.00	1.00	174.87	11.71	896.54
30.00	100.00	40.00	9.00	4.00	180.00	12.27	900.77
30.00	100.00	40.00	9.00	7.00	180.00	12.27	900.77
30.00	100.00	40.00	9.00	10.00	180.00	12.27	900.77
30.00	100.00	40.00	16.00	1.00	174.87	18.71	1487.27
30.00	100.00	40.00	16.00	4.00	180.00	19.27	1491.50
30.00	100.00	40.00	16.00	7.00	180.00	19.27	1491.50
30.00	100.00	40.00	16.00	10.00	180.00	19.27	1491.50
30.00	100.00	40.00	22.00	1.00	174.87	24.71	1993.61
30.00	100.00	40.00	22.00	4.00	180.00	25.27	1997.84
30.00	100.00	40.00	22.00	7.00	180.00	25.27	1997.84
30.00	100.00	40.00	22.00	10.00	180.00	25.27	1997.84
30.00	100.00	30.00	2.50	1.00	172.37	6.04	402.69
30.00	100.00	30.00	2.50	4.00	173.47	7.01	415.72
30.00	100.00	30.00	2.50	7.00	180.00	7.25	416.27
30.00	100.00	30.00	2.50	10.00	180.00	7.25	416.27
30.00	100.00	30.00	9.00	1.00	172.37	12.54	951.23
30.00	100.00	30.00	9.00	4.00	178.47	13.51	964.26
30.00	100.00	30.00	9.00	7.00	180.00	13.75	964.30
30.00	100.00	30.00	9.00	10.00	180.00	13.75	964.30
30.00	100.00	30.00	16.00	1.00	172.37	19.54	1541.96
30.00	100.00	30.00	16.00	4.00	178.47	20.51	1554.99
30.00	100.00	30.00	16.00	7.00	180.00	20.75	1555.54
30.00	100.00	30.00	16.00	10.00	180.00	20.75	1555.54
30.00	100.00	30.00	22.00	1.00	172.37	25.54	2049.30
30.00	100.00	30.00	22.00	4.00	178.47	26.51	2061.33
30.00	100.00	30.00	22.00	7.00	180.00	26.75	2061.88
30.00	100.00	30.00	22.00	10.00	180.00	26.75	2061.88

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
30.00	[illegible]	20.00	2.50	1.00	168.81	7.23	490.44
30.00	[illegible]	20.00	2.50	4.00	173.94	8.52	523.06
30.00	[illegible]	20.00	2.50	7.00	179.06	9.81	536.31
30.00	[illegible]	20.00	2.50	10.00	180.00	10.04	536.62
30.00	[illegible]	20.00	9.00	1.00	168.81	13.73	1038.98
30.00	[illegible]	20.00	9.00	4.00	173.94	15.02	1071.60
30.00	[illegible]	20.00	9.00	7.00	179.08	16.31	1084.84
30.00	[illegible]	20.00	9.00	10.00	180.00	16.54	1085.16
30.00	[illegible]	20.00	16.00	1.00	168.81	20.73	1629.71
30.00	[illegible]	20.00	16.00	4.00	173.94	22.02	1662.33
30.00	[illegible]	20.00	16.00	7.00	179.08	23.31	1675.57
30.00	[illegible]	20.00	16.00	10.00	180.00	23.54	1675.89
30.00	[illegible]	20.00	22.00	1.00	168.81	26.73	2136.05
30.00	[illegible]	20.00	22.00	4.00	173.94	28.02	2168.67
30.00	[illegible]	20.00	22.00	7.00	179.08	29.31	2181.91
30.00	[illegible]	20.00	22.00	10.00	180.00	29.54	2182.23
30.00	[illegible]	10.00	2.50	1.00	162.91	9.20	661.58
30.00	[illegible]	10.00	2.50	4.00	165.43	11.02	743.98
30.00	[illegible]	10.00	2.50	7.00	169.95	12.85	806.17
30.00	[illegible]	10.00	2.50	10.00	173.47	14.68	850.61
30.00	[illegible]	10.00	9.00	1.00	162.91	15.70	1210.12
30.00	[illegible]	10.00	9.00	4.00	166.43	17.52	1291.61
30.00	[illegible]	10.00	9.00	7.00	169.95	19.35	1354.70
30.00	[illegible]	10.00	9.00	10.00	173.47	21.18	1399.15
30.00	[illegible]	10.00	16.00	1.00	162.91	22.70	1800.65
30.00	[illegible]	10.00	16.00	4.00	166.43	24.52	1882.35
30.00	[illegible]	10.00	16.00	7.00	169.95	26.35	1945.44
30.00	[illegible]	10.00	16.00	10.00	173.47	28.18	1989.88
30.00	[illegible]	10.00	22.00	1.00	162.91	28.70	2307.19
30.00	[illegible]	10.00	22.00	4.00	166.43	30.52	2388.69
30.00	[illegible]	10.00	22.00	7.00	169.95	32.35	2451.78
30.00	[illegible]	10.00	22.00	10.00	173.47	34.18	2496.22

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
30.00	12[illegible].00	40.00	2.50	1.00	173.70	5.60	447.40
30.00	12[illegible].00	40.00	2.50	4.00	180.00	6.42	456.58
30.00	12[illegible].00	40.00	2.50	7.00	180.00	6.42	456.58
30.00	12[illegible].00	40.00	2.50	10.00	180.00	6.42	456.58
30.00	12[illegible].00	40.00	9.00	1.00	173.70	12.10	1105.65
30.00	12[illegible].00	40.00	9.00	4.00	180.00	12.92	1114.82
30.00	12[illegible].00	40.00	9.00	7.00	180.00	12.92	1114.82
30.00	12[illegible].00	40.00	9.00	10.00	180.00	12.92	1114.82
30.00	12[illegible].00	40.00	16.00	1.00	173.70	19.10	1814.52
30.00	12[illegible].00	40.00	16.00	4.00	180.00	19.92	1823.70
30.00	12[illegible].00	40.00	16.00	7.00	180.00	19.92	1823.70
30.00	12[illegible].00	40.00	16.00	10.00	180.00	19.92	1823.70
30.00	12[illegible].00	40.00	22.00	1.00	173.70	25.10	2422.13
30.00	12[illegible].00	40.00	22.00	4.00	180.00	25.92	2431.31
30.00	12[illegible].00	40.00	22.00	7.00	180.00	25.92	2431.31
30.00	12[illegible].00	40.00	22.00	10.00	180.00	25.92	2431.31
30.00	12[illegible].00	30.00	2.50	1.00	171.01	6.50	521.71
30.00	12[illegible].00	30.00	2.50	4.00	176.74	7.59	545.23
30.00	12[illegible].00	30.00	2.50	7.00	180.00	8.20	548.79
30.00	12[illegible].00	30.00	2.50	10.00	180.00	8.20	548.79
30.00	12[illegible].00	30.00	9.00	1.00	171.01	13.00	1179.95
30.00	12[illegible].00	30.00	9.00	4.00	175.74	14.09	1203.47
30.00	12[illegible].00	30.00	9.00	7.00	180.00	14.70	1207.04
30.00	12[illegible].00	30.00	9.00	10.00	180.00	14.70	1207.04
30.00	12[illegible].00	30.00	16.00	1.00	171.01	20.00	1888.83
30.00	12[illegible].00	30.00	16.00	4.00	176.74	21.09	1912.35
30.00	12[illegible].00	30.00	16.00	7.00	180.00	21.70	1915.91
30.00	12[illegible].00	30.00	16.00	10.00	180.00	21.70	1915.91
30.00	12[illegible].00	30.00	22.00	1.00	171.01	26.00	2496.44
30.00	12[illegible].00	30.00	22.00	4.00	176.74	27.09	2519.96
30.00	12[illegible].00	30.00	22.00	7.00	180.00	27.70	2523.52
30.00	12[illegible].00	30.00	22.00	10.00	180.00	27.70	2523.52

********** BLUNDER ANALYSIS - DUAL AIRCRAFT APPROVED ********** PAGE = 44

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
30.00	120.00	20.00	2.50	1.00	167.32	7.73	636.79
30.00	120.00	20.00	2.50	4.00	172.05	9.15	688.45
30.00	120.00	20.00	2.50	7.00	176.77	10.56	716.59
30.00	120.00	20.00	2.50	10.00	180.00	11.55	722.10
30.00	120.00	20.00	9.00	1.00	167.32	14.23	1295.04
30.00	120.00	20.00	9.00	4.00	172.05	15.65	1346.70
30.00	120.00	20.00	9.00	7.00	176.77	17.08	1374.80
30.00	120.00	20.00	9.00	10.00	180.00	18.05	1380.34
30.00	120.00	20.00	16.00	1.00	167.32	21.23	2003.91
30.00	120.00	20.00	16.00	4.00	172.05	22.65	2055.57
30.00	120.00	20.00	16.00	7.00	176.77	24.08	2083.67
30.00	120.00	20.00	16.00	10.00	180.00	25.05	2089.22
30.00	120.00	20.00	22.00	1.00	167.32	27.23	2611.52
30.00	120.00	20.00	22.00	4.00	172.05	28.65	2663.18
30.00	120.00	20.00	22.00	7.00	176.77	30.08	2691.28
30.00	120.00	20.00	22.00	10.00	180.00	31.05	2696.83
30.00	120.00	10.00	2.50	1.00	161.51	9.66	848.05
30.00	120.00	10.00	2.50	4.00	164.65	11.62	963.24
30.00	120.00	10.00	2.50	7.00	167.78	13.57	1057.52
30.00	120.00	10.00	2.50	10.00	170.92	15.53	1130.63
30.00	120.00	10.00	9.00	1.00	161.51	16.16	1506.30
30.00	120.00	10.00	9.00	4.00	164.65	18.12	1621.48
30.00	120.00	10.00	9.00	7.00	167.78	20.07	1715.77
30.00	120.00	10.00	9.00	10.00	170.92	22.03	1788.87
30.00	120.00	10.00	16.00	1.00	161.51	23.16	2215.17
30.00	120.00	10.00	16.00	4.00	164.65	25.12	2330.36
30.00	120.00	10.00	16.00	7.00	167.78	27.07	2424.65
30.00	120.00	10.00	16.00	10.00	170.92	29.03	2497.75
30.00	120.00	10.00	22.00	1.00	161.51	29.16	2822.78
30.00	120.00	10.00	22.00	4.00	164.65	31.12	2937.97
30.00	120.00	10.00	22.00	7.00	167.78	33.07	3032.25
30.00	120.00	10.00	22.00	10.00	170.92	35.05	3105.36

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
30.00	14[illegible].00	40.00	2.50	1.00	172.64	5.95	555.17
30.00	14[illegible].00	40.00	2.50	4.00	178.81	6.90	571.78
30.00	14[illegible].00	40.00	2.50	7.00	180.00	7.08	572.22
30.00	14[illegible].00	40.00	2.50	10.00	180.00	7.08	572.22
30.00	14[illegible].00	40.00	9.00	1.00	172.64	12.45	1323.12
30.00	14[illegible].00	40.00	9.00	4.00	178.81	13.40	1339.73
30.00	14[illegible].00	40.00	9.00	7.00	180.00	13.58	1340.17
30.00	14[illegible].00	40.00	9.00	10.00	180.00	13.58	1340.17
30.00	14[illegible].00	40.00	16.00	1.00	172.64	19.45	2150.15
30.00	14[illegible].00	40.00	16.00	4.00	178.81	20.40	2166.75
30.00	14[illegible].00	40.00	16.00	7.00	180.00	20.58	2167.20
30.00	14[illegible].00	40.00	16.00	10.00	180.00	20.58	2167.20
30.00	14[illegible].00	40.00	22.00	1.00	172.64	25.45	2859.03
30.00	14[illegible].00	40.00	22.00	4.00	178.81	26.40	2875.63
30.00	14[illegible].00	40.00	22.00	7.00	180.00	26.58	2876.07
30.00	14[illegible].00	40.00	22.00	10.00	180.00	26.58	2876.07
30.00	14[illegible].00	30.00	2.50	1.00	169.81	6.90	650.40
30.00	14[illegible].00	30.00	2.50	4.00	175.22	8.09	687.28
30.00	14[illegible].00	30.00	2.50	7.00	180.00	9.16	6[illegible]7.74
30.00	14[illegible].00	30.00	2.50	10.00	180.00	9.16	697.74
30.00	14[illegible].00	30.00	9.00	1.00	169.81	13.40	1418.35
30.00	14[illegible].00	30.00	9.00	4.00	175.22	14.59	1455.23
30.00	14[illegible].00	30.00	9.00	7.00	180.00	15.66	1465.69
30.00	14[illegible].00	30.00	9.00	10.00	180.00	15.66	1465.69
30.00	14[illegible].00	30.00	16.00	1.00	169.81	20.40	2245.37
30.00	14[illegible].00	30.00	16.00	4.00	175.22	21.59	2282.26
30.00	14[illegible].00	30.00	16.00	7.00	180.00	22.66	2292.71
30.00	14[illegible].00	30.00	16.00	10.00	180.00	22.66	2292.71
30.00	14[illegible].00	30.00	22.00	1.00	169.81	26.40	2954.25
30.00	14[illegible].00	30.00	22.00	4.00	175.22	27.59	2991.13
30.00	14[illegible].00	30.00	22.00	7.00	180.00	28.66	3001.59
30.00	14[illegible].00	30.00	22.00	10.00	180.00	28.66	3001.59

*********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER *********** PAGE = 46

[illegible]	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
[illegible]	140.00	20.00	2.50	1.00	166.05	8.15	793.19
[illegible]	140.00	20.00	2.50	4.00	170.43	9.69	867.35
[illegible]	140.00	20.00	2.50	7.00	174.81	11.23	914.10
[illegible]	140.00	20.00	2.50	10.00	179.19	12.77	933.15
[illegible]	140.00	20.00	9.00	1.00	166.05	14.65	1561.14
[illegible]	140.00	20.00	9.00	4.00	170.43	16.19	1635.30
[illegible]	140.00	20.00	9.00	7.00	174.81	17.73	1682.05
[illegible]	140.00	20.00	9.00	10.00	179.19	19.27	1701.10
[illegible]	140.00	20.00	16.00	1.00	166.05	21.65	2388.16
[illegible]	140.00	20.00	16.00	4.00	170.43	23.19	2462.32
[illegible]	140.00	20.00	16.00	7.00	174.81	24.73	2509.07
[illegible]	140.00	20.00	16.00	10.00	179.19	26.27	2528.13
[illegible]	140.00	20.00	22.00	1.00	166.05	27.65	3097.04
[illegible]	140.00	20.00	22.00	4.00	170.43	29.19	3171.20
[illegible]	140.00	20.00	22.00	7.00	174.81	30.73	3217.95
[illegible]	140.00	20.00	22.00	10.00	179.19	32.27	3237.01
[illegible]	140.00	10.00	2.50	1.00	160.38	10.04	1041.93
[illegible]	140.00	10.00	2.50	4.00	163.21	12.10	1193.71
[illegible]	140.00	10.00	2.50	7.00	166.04	14.15	1322.51
[illegible]	140.00	10.00	2.50	10.00	168.87	16.21	1428.01
[illegible]	140.00	10.00	9.00	1.00	160.38	16.54	1809.88
[illegible]	140.00	10.00	9.00	4.00	163.21	18.60	1961.66
[illegible]	140.00	10.00	9.00	7.00	166.04	20.65	2090.46
[illegible]	140.00	10.00	9.00	10.00	168.87	22.71	2195.96
[illegible]	140.00	10.00	16.00	1.00	160.38	23.54	2636.90
[illegible]	140.00	10.00	16.00	4.00	163.21	25.60	2788.68
[illegible]	140.00	10.00	16.00	7.00	166.04	27.65	2917.48
[illegible]	140.00	10.00	16.00	10.00	168.87	29.71	3022.99
[illegible]	140.00	10.00	22.00	1.00	160.38	29.54	3345.78
[illegible]	140.00	10.00	22.00	4.00	163.21	31.60	3497.56
[illegible]	140.00	10.00	22.00	7.00	166.04	33.65	3626.36
[illegible]	140.00	10.00	22.00	10.00	168.87	35.71	3731.86

*********** BLUNDER ANALYSIS - DUAL AIRCRAFT [illegible] ***********

BLUNDER DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
30.00	160.00	40.00	2.50	1.00	171.66	6.28	670.65
30.00	160.00	40.00	2.50	4.00	177.57	7.31	696.75
30.00	160.00	40.00	2.50	7.00	180.00	7.73	699.17
30.00	160.00	40.00	2.50	10.00	180.00	7.73	699.17
30.00	160.00	40.00	9.00	1.00	171.66	12.78	1548.31
30.00	160.00	40.00	9.00	4.00	177.57	13.81	1574.40
30.00	160.00	40.00	9.00	7.00	180.00	14.23	1576.83
30.00	160.00	40.00	9.00	10.00	180.00	14.23	1576.83
30.00	160.00	40.00	16.00	1.00	171.66	19.78	2493.48
30.00	160.00	40.00	16.00	4.00	177.57	20.81	2519.57
30.00	160.00	40.00	16.00	7.00	180.00	21.23	2522.00
30.00	160.00	40.00	16.00	10.00	180.00	21.23	2522.00
30.00	160.00	40.00	22.00	1.00	171.66	25.78	3303.62
30.00	160.00	40.00	22.00	4.00	177.57	26.81	3329.72
30.00	160.00	40.00	22.00	7.00	180.00	27.23	3332.14
30.00	160.00	40.00	22.00	10.00	180.00	27.23	3332.14
30.00	160.00	30.00	2.50	1.00	168.74	7.25	787.65
30.00	160.00	30.00	2.50	4.00	173.86	8.55	840.58
30.00	160.00	30.00	2.50	7.00	178.97	9.84	862.47
30.00	160.00	30.00	2.50	10.00	180.00	10.11	863.11
30.00	160.00	30.00	9.00	1.00	168.74	13.75	1665.31
30.00	160.00	30.00	9.00	4.00	173.86	15.05	1718.23
30.00	160.00	30.00	9.00	7.00	178.97	16.34	1740.13
30.00	160.00	30.00	9.00	10.00	180.00	16.61	1740.77
30.00	160.00	30.00	16.00	1.00	168.74	20.75	2610.48
30.00	160.00	30.00	16.00	4.00	173.86	22.05	2663.40
30.00	160.00	30.00	16.00	7.00	178.97	23.34	2685.30
30.00	160.00	30.00	16.00	10.00	180.00	23.61	2685.94
30.00	160.00	30.00	22.00	1.00	168.74	26.75	3420.63
30.00	160.00	30.00	22.00	4.00	173.86	28.05	3473.55
30.00	160.00	30.00	22.00	7.00	178.97	29.34	3495.45
30.00	160.00	30.00	22.00	10.00	180.00	29.61	3496.08

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
30.00	160.00	20.00	2.50	1.00	164.96	8.51	957.95
30.00	160.00	20.00	2.50	4.00	169.03	10.16	1057.61
30.00	160.00	20.00	2.50	7.00	173.11	11.80	1126.33
30.00	160.00	20.00	2.50	10.00	177.19	13.44	1163.75
30.00	160.00	20.00	9.00	1.00	164.96	15.01	1835.61
30.00	160.00	20.00	9.00	4.00	169.03	16.66	1935.27
30.00	160.00	20.00	9.00	7.00	173.11	18.30	2003.99
30.00	160.00	20.00	9.00	10.00	177.19	19.94	2041.41
30.00	160.00	20.00	16.00	1.00	164.96	22.01	2780.78
30.00	160.00	20.00	16.00	4.00	169.03	23.66	2880.44
30.00	160.00	20.00	16.00	7.00	173.11	25.30	2949.16
30.00	160.00	20.00	16.00	10.00	177.19	26.94	2986.58
30.00	160.00	20.00	22.00	1.00	164.96	28.01	3590.92
30.00	160.00	20.00	22.00	4.00	169.03	29.66	3690.59
30.00	160.00	20.00	22.00	7.00	173.11	31.30	3759.30
30.00	160.00	20.00	22.00	10.00	177.19	32.94	3796.72
30.00	160.00	10.00	2.50	1.00	159.45	10.35	1241.40
30.00	160.00	10.00	2.50	4.00	162.03	12.49	1432.01
30.00	160.00	10.00	2.50	7.00	164.61	14.63	1597.89
30.00	160.00	10.00	2.50	10.00	167.19	16.77	1738.69
30.00	160.00	10.00	9.00	1.00	159.45	16.85	2119.05
30.00	160.00	10.00	9.00	4.00	162.03	18.99	2309.67
30.00	160.00	10.00	9.00	7.00	164.61	21.13	2475.55
30.00	160.00	10.00	9.00	10.00	167.19	23.27	2616.35
30.00	160.00	10.00	16.00	1.00	159.45	23.85	3064.22
30.00	160.00	10.00	16.00	4.00	162.03	25.99	3254.84
30.00	160.00	10.00	16.00	7.00	164.61	28.13	3420.72
30.00	160.00	10.00	16.00	10.00	167.19	30.27	3561.52
30.00	160.00	10.00	22.00	1.00	159.45	29.85	3874.37
30.00	160.00	10.00	22.00	4.00	162.03	31.99	4064.99
30.00	160.00	10.00	22.00	7.00	164.61	34.13	4230.86
30.00	160.00	10.00	22.00	10.00	167.19	36.27	4371.66

*********** BLUNDER ANALYSIS - DUAL AIRCRAFT [illegible] OVER *********** PAGE = 49

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
[illegible]	[illegible]	40.00	2.50	1.00	175.13	5.12	288.82
[illegible]	[illegible]	40.00	2.50	4.00	180.00	5.44	290.19
[illegible]	[illegible]	40.00	2.50	7.00	180.00	5.44	290.19
[illegible]	[illegible]	40.00	2.50	10.00	180.00	5.44	290.19
[illegible]	[illegible]	40.00	9.00	1.00	175.13	11.62	754.26
[illegible]	[illegible]	40.00	9.00	4.00	180.00	11.94	755.64
[illegible]	[illegible]	40.00	9.00	7.00	180.00	11.94	755.64
[illegible]	[illegible]	40.00	9.00	10.00	180.00	11.94	755.64
[illegible]	[illegible]	40.00	16.00	1.00	175.13	18.62	1255.52
[illegible]	[illegible]	40.00	16.00	4.00	180.00	18.94	1256.89
[illegible]	[illegible]	40.00	16.00	7.00	180.00	18.94	1256.89
[illegible]	[illegible]	40.00	16.00	10.00	180.00	18.94	1256.89
[illegible]	[illegible]	40.00	22.00	1.00	175.13	24.62	1685.16
[illegible]	[illegible]	40.00	22.00	4.00	180.00	24.94	1686.53
[illegible]	[illegible]	40.00	22.00	7.00	180.00	24.94	1686.53
[illegible]	[illegible]	40.00	22.00	10.00	180.00	24.94	1686.53
[illegible]	[illegible]	30.00	2.50	1.00	172.35	6.05	335.68
[illegible]	[illegible]	30.00	2.50	4.00	179.35	6.72	340.55
[illegible]	[illegible]	30.00	2.50	7.00	180.00	6.78	340.59
[illegible]	[illegible]	30.00	2.50	10.00	180.00	6.78	340.59
[illegible]	[illegible]	30.00	9.00	1.00	172.35	12.55	801.13
[illegible]	[illegible]	30.00	9.00	4.00	179.35	13.22	806.00
[illegible]	[illegible]	30.00	9.00	7.00	180.00	13.28	806.04
[illegible]	[illegible]	30.00	9.00	10.00	180.00	13.28	806.04
[illegible]	[illegible]	30.00	16.00	1.00	172.35	19.55	1302.38
[illegible]	[illegible]	30.00	16.00	4.00	179.35	20.22	1307.25
[illegible]	[illegible]	30.00	16.00	7.00	180.00	20.28	1307.29
[illegible]	[illegible]	30.00	16.00	10.00	180.00	20.28	1307.29
[illegible]	[illegible]	30.00	22.00	1.00	172.35	25.55	1732.02
[illegible]	[illegible]	30.00	22.00	4.00	179.35	26.22	1736.90
[illegible]	[illegible]	30.00	22.00	7.00	180.00	26.28	1736.94
[illegible]	[illegible]	30.00	22.00	10.00	180.00	26.28	1736.94

********** BLUNDER ANALYSIS - DUAL AIRCRAFT [illegible] ********** PAGE = 50

[illegible] ANGLE (DEG.)	[illegible] VELOCITY (KNOTS)	BLUNDERER BANK ANGLE (DEG.)	BLUNDERER SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
[illegible]	[illegible]	20.00	2.50	1.00	168.05	7.48	416.34
[illegible]	[illegible]	20.00	2.50	4.00	174.24	8.42	430.90
[illegible]	[illegible]	20.00	2.50	7.00	180.00	9.29	435.31
[illegible]	[illegible]	20.00	2.50	10.00	180.00	9.29	435.31
[illegible]	[illegible]	20.00	9.00	1.00	168.05	13.98	881.79
[illegible]	[illegible]	20.00	9.00	4.00	174.24	14.92	896.35
[illegible]	[illegible]	20.00	9.00	7.00	180.00	15.79	900.76
[illegible]	[illegible]	20.00	9.00	10.00	180.00	15.79	900.76
[illegible]	[illegible]	20.00	16.00	1.00	168.05	20.96	1383.04
[illegible]	[illegible]	20.00	16.00	4.00	174.24	21.92	1397.60
[illegible]	[illegible]	20.00	16.00	7.00	180.00	22.79	1402.01
[illegible]	[illegible]	20.00	16.00	10.00	180.00	22.79	1402.01
[illegible]	[illegible]	20.00	22.00	1.00	168.05	26.98	1812.69
[illegible]	[illegible]	20.00	22.00	4.00	174.24	27.92	1827.25
[illegible]	[illegible]	20.00	22.00	7.00	180.00	28.79	1831.66
[illegible]	[illegible]	20.00	22.00	10.00	180.00	28.79	1831.66
[illegible]	[illegible]	10.00	2.50	1.00	159.82	10.23	597.18
[illegible]	[illegible]	10.00	2.50	4.00	164.47	11.68	642.14
[illegible]	[illegible]	10.00	2.50	7.00	169.13	13.12	675.63
[illegible]	[illegible]	10.00	2.50	10.00	173.78	14.57	697.42
[illegible]	[illegible]	10.00	9.00	1.00	159.82	16.73	1062.63
[illegible]	[illegible]	10.00	9.00	4.00	164.47	18.18	1107.59
[illegible]	[illegible]	10.00	9.00	7.00	169.13	19.62	1141.08
[illegible]	[illegible]	10.00	9.00	10.00	173.78	21.07	1162.87
[illegible]	[illegible]	10.00	16.00	1.00	159.82	23.73	1563.88
[illegible]	[illegible]	10.00	16.00	4.00	164.47	25.18	1608.84
[illegible]	[illegible]	10.00	16.00	7.00	169.13	26.62	1642.33
[illegible]	[illegible]	10.00	16.00	10.00	173.78	28.07	1664.13
[illegible]	[illegible]	10.00	22.00	1.00	159.82	29.73	1993.52
[illegible]	[illegible]	10.00	22.00	4.00	164.47	31.18	2038.49
[illegible]	[illegible]	10.00	22.00	7.00	169.13	32.62	2071.98
[illegible]	[illegible]	10.00	22.00	10.00	173.78	34.07	2093.77

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ********** PAGE = 51

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
45.00	[illegible]	40.00	2.50	1.00	173.05	5.82	431.36
45.00	[illegible]	40.00	2.50	4.00	180.00	6.42	436.33
45.00	[illegible]	40.00	2.50	7.00	180.00	6.42	436.33
45.00	[illegible]	40.00	2.50	10.00	180.00	6.42	436.33
45.00	[illegible]	40.00	9.00	1.00	173.05	12.32	1051.96
45.00	[illegible]	40.00	9.00	4.00	180.00	12.92	1056.93
45.00	[illegible]	40.00	9.00	7.00	180.00	12.92	1056.93
45.00	[illegible]	40.00	9.00	10.00	180.00	12.92	1056.93
45.00	[illegible]	40.00	16.00	1.00	173.05	19.32	1720.30
45.00	[illegible]	40.00	16.00	4.00	180.00	19.92	1725.26
45.00	[illegible]	40.00	16.00	7.00	180.00	19.92	1725.26
45.00	[illegible]	40.00	16.00	10.00	180.00	19.92	1725.26
45.00	[illegible]	40.00	22.00	1.00	173.05	25.32	2293.16
45.00	[illegible]	40.00	22.00	4.00	180.00	25.92	2298.12
45.00	[illegible]	40.00	22.00	7.00	180.00	25.92	2298.12
45.00	[illegible]	40.00	22.00	10.00	180.00	25.92	2298.12
45.00	[illegible]	30.00	2.50	1.00	169.78	6.91	510.35
45.00	[illegible]	30.00	2.50	4.00	176.30	7.73	523.88
45.00	[illegible]	30.00	2.50	7.00	180.00	8.20	525.93
45.00	[illegible]	30.00	2.50	10.00	180.00	8.20	525.93
45.00	[illegible]	30.00	9.00	1.00	169.78	13.41	1130.95
45.00	[illegible]	30.00	9.00	4.00	176.30	14.23	1144.48
45.00	[illegible]	30.00	9.00	7.00	180.00	14.70	1146.53
45.00	[illegible]	30.00	9.00	10.00	180.00	14.70	1146.53
45.00	[illegible]	30.00	16.00	1.00	169.78	20.41	1799.29
45.00	[illegible]	30.00	16.00	4.00	176.30	21.23	1812.81
45.00	[illegible]	30.00	16.00	7.00	180.00	21.70	1814.86
45.00	[illegible]	30.00	16.00	10.00	180.00	21.70	1814.86
45.00	[illegible]	30.00	22.00	1.00	169.78	26.41	2372.15
45.00	[illegible]	30.00	22.00	4.00	176.30	27.23	2385.67
45.00	[illegible]	30.00	22.00	7.00	180.00	27.70	2387.72
45.00	[illegible]	30.00	22.00	10.00	180.00	27.70	2387.72

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
45.00	[illegible]	20.00	2.50	1.00	164.94	8.52	640.89
45.00	[illegible]	20.00	2.50	4.00	170.55	9.65	673.22
45.00	80.00	20.00	2.50	7.00	176.17	10.78	690.84
45.00	80.00	20.00	2.50	10.00	180.00	11.55	694.32
45.00	[illegible]	20.00	9.00	1.00	164.94	15.02	1261.49
45.00	80.00	20.00	9.00	4.00	170.55	16.15	1293.82
45.00	[illegible]	20.00	9.00	7.00	176.17	17.28	1311.44
45.00	[illegible]	20.00	9.00	10.00	180.00	18.05	1314.92
45.00	[illegible]	20.00	16.00	1.00	164.94	22.02	1929.82
45.00	[illegible]	20.00	16.00	4.00	170.55	23.15	1962.16
45.00	[illegible]	20.00	16.00	7.00	176.17	24.28	1979.73
45.00	[illegible]	20.00	16.00	10.00	180.00	25.05	1983.26
45.00	[illegible]	20.00	22.00	1.00	164.94	28.02	2502.68
45.00	[illegible]	20.00	22.00	4.00	170.55	29.15	2535.02
45.00	[illegible]	20.00	22.00	7.00	176.17	30.28	2552.64
45.00	[illegible]	20.00	22.00	10.00	180.00	31.05	2556.12
45.00	[illegible]	10.00	2.50	1.00	156.38	11.37	910.16
45.00	[illegible]	10.00	2.50	4.00	160.39	13.04	992.90
45.00	[illegible]	10.00	2.50	7.00	164.40	14.70	1060.95
45.00	[illegible]	10.00	2.50	10.00	168.40	16.37	1113.66
45.00	[illegible]	10.00	9.00	1.00	156.38	17.87	1530.76
45.00	[illegible]	10.00	9.00	4.00	160.39	19.54	1613.50
45.00	[illegible]	10.00	9.00	7.00	164.40	21.20	1681.45
45.00	[illegible]	10.00	9.00	10.00	168.40	22.87	1734.26
45.00	[illegible]	10.00	16.00	1.00	156.38	24.87	2199.09
45.00	[illegible]	10.00	16.00	4.00	160.39	26.54	2281.84
45.00	[illegible]	10.00	16.00	7.00	164.40	28.20	2349.78
45.00	[illegible]	10.00	16.00	10.00	168.40	29.87	2402.60
45.00	[illegible]	10.00	22.00	1.00	156.38	30.87	2771.95
45.00	[illegible]	10.00	22.00	4.00	160.39	32.54	2854.70
45.00	[illegible]	10.00	22.00	7.00	164.40	34.20	2922.64
45.00	[illegible]	10.00	22.00	10.00	168.40	35.87	2975.46

********** BLUNDER ANALYSIS - DUAL AIRCRAFT : AIR OVER **********

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
45.00	100.00	40.00	2.50	1.00	171.17	6.44	594.67
45.00	100.00	40.00	2.50	4.00	177.95	7.18	606.50
45.00	100.00	40.00	2.50	7.00	180.00	7.41	607.17
45.00	100.00	40.00	2.50	10.00	180.00	7.41	607.17
45.00	100.00	40.00	9.00	1.00	171.17	12.94	1370.42
45.00	100.00	40.00	9.00	4.00	177.95	13.68	1382.24
45.00	100.00	40.00	9.00	7.00	180.00	13.91	1382.92
45.00	100.00	40.00	9.00	10.00	180.00	13.91	1382.92
45.00	100.00	40.00	16.00	1.00	171.17	19.94	2205.84
45.00	100.00	40.00	16.00	4.00	177.95	20.68	2217.67
45.00	100.00	40.00	16.00	7.00	180.00	20.91	2218.34
45.00	100.00	40.00	16.00	10.00	180.00	20.91	2218.34
45.00	100.00	40.00	22.00	1.00	171.17	25.94	2921.92
45.00	100.00	40.00	22.00	4.00	177.95	26.68	2933.74
45.00	100.00	40.00	22.00	7.00	180.00	26.91	2934.41
45.00	100.00	40.00	22.00	10.00	180.00	26.91	2934.41
45.00	100.00	50.00	2.50	1.00	167.53	7.66	711.05
45.00	100.00	50.00	2.50	4.00	173.63	8.62	737.72
45.00	100.00	50.00	2.50	7.00	179.73	9.59	747.16
45.00	100.00	50.00	2.50	10.00	180.00	9.63	747.17
45.00	100.00	50.00	9.00	1.00	167.53	14.16	1486.80
45.00	100.00	50.00	9.00	4.00	173.63	15.12	1513.47
45.00	100.00	50.00	9.00	7.00	179.73	16.09	1522.90
45.00	100.00	50.00	9.00	10.00	180.00	16.13	1522.92
45.00	100.00	50.00	16.00	1.00	167.53	21.16	2322.22
45.00	100.00	50.00	16.00	4.00	173.63	22.12	2348.89
45.00	100.00	50.00	16.00	7.00	179.73	23.09	2358.32
45.00	100.00	50.00	16.00	10.00	180.00	23.13	2358.34
45.00	100.00	50.00	22.00	1.00	167.53	27.16	3038.29
45.00	100.00	50.00	22.00	4.00	173.63	28.12	3064.97
45.00	100.00	50.00	22.00	7.00	179.73	29.09	3074.40
45.00	100.00	50.00	22.00	10.00	180.00	29.13	3074.42

********** BLUNDER ANALYSIS - DUAL AIRCRAFT [illegible] LEVEL **********   PAGE = 58

[illegible]	BLUNDERER VELOCITY (KNOTS)	BLUNDERER BANK ANGLE (DEG.)	BLUNDERER SUSPECTED DELAYS (SEC.)	ADJACENT SUSPECTED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
[illegible]	[illegible]	20.00	2.50	1.00	162.37	9.38	896.06
[illegible]	[illegible]	20.00	2.50	4.00	167.50	10.67	952.64
[illegible]	[illegible]	20.00	2.50	7.00	172.63	11.96	990.19
[illegible]	[illegible]	20.00	2.50	10.00	177.76	13.25	1008.43
[illegible]	[illegible]	20.00	9.00	1.00	162.37	15.88	1671.81
[illegible]	[illegible]	20.00	9.00	4.00	167.50	17.17	1728.38
[illegible]	[illegible]	20.00	9.00	7.00	172.63	18.46	1765.94
[illegible]	[illegible]	20.00	9.00	10.00	177.76	19.75	1784.18
[illegible]	[illegible]	20.00	16.00	1.00	162.37	22.88	2507.23
[illegible]	[illegible]	20.00	16.00	4.00	167.50	24.17	2563.81
[illegible]	[illegible]	20.00	16.00	7.00	172.63	25.46	2601.36
[illegible]	[illegible]	20.00	16.00	10.00	177.76	26.75	2619.60
[illegible]	[illegible]	20.00	22.00	1.00	162.37	28.88	3223.31
[illegible]	[illegible]	20.00	22.00	4.00	167.50	30.17	3279.88
[illegible]	[illegible]	20.00	22.00	7.00	172.63	31.46	3317.43
[illegible]	[illegible]	20.00	22.00	10.00	177.76	32.75	3335.67
[illegible]	[illegible]	10.00	2.50	1.00	153.78	12.24	1251.47
[illegible]	[illegible]	10.00	2.50	4.00	157.30	14.07	1379.12
[illegible]	[illegible]	10.00	2.50	7.00	160.82	15.89	1489.30
[illegible]	[illegible]	10.00	2.50	10.00	164.34	17.72	1581.59
[illegible]	[illegible]	10.00	9.00	1.00	153.78	18.74	2027.22
[illegible]	[illegible]	10.00	9.00	4.00	157.30	20.57	2154.87
[illegible]	[illegible]	10.00	9.00	7.00	160.82	22.39	2265.05
[illegible]	[illegible]	10.00	9.00	10.00	164.34	24.22	2357.34
[illegible]	[illegible]	10.00	16.00	1.00	153.78	25.74	2862.64
[illegible]	[illegible]	10.00	16.00	4.00	157.30	27.57	2990.29
[illegible]	[illegible]	10.00	16.00	7.00	160.82	29.39	3100.47
[illegible]	[illegible]	10.00	16.00	10.00	164.34	31.22	3192.76
[illegible]	[illegible]	10.00	22.00	1.00	153.78	31.74	3578.72
[illegible]	[illegible]	10.00	22.00	4.00	157.30	33.57	3706.36
[illegible]	[illegible]	[illegible]	22.00	7.00	160.32	35.39	3816.54
[illegible]	[illegible]	[illegible]	22.00	10.00	164.34	37.22	3908.83

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
45.00	120.00	40.00	2.50	1.00	169.47	7.01	777.15
45.00	120.00	40.00	2.50	4.00	175.93	7.86	798.90
45.00	120.00	40.00	2.50	7.00	180.00	8.39	802.72
45.00	120.00	40.00	2.50	10.00	180.00	8.39	802.72
45.00	120.00	40.00	9.00	1.00	169.47	13.51	1708.05
45.00	120.00	40.00	9.00	4.00	175.93	14.36	1729.79
45.00	120.00	40.00	9.00	7.00	180.00	14.89	1733.62
45.00	120.00	40.00	9.00	10.00	180.00	14.89	1733.62
45.00	120.00	40.00	16.00	1.00	169.47	20.51	2710.55
45.00	120.00	40.00	16.00	4.00	175.93	21.36	2732.30
45.00	120.00	40.00	16.00	7.00	180.00	21.89	2736.12
45.00	120.00	40.00	16.00	10.00	180.00	21.89	2736.12
45.00	120.00	40.00	22.00	1.00	169.47	26.51	3569.84
45.00	120.00	40.00	22.00	4.00	175.93	27.36	3591.59
45.00	120.00	40.00	22.00	7.00	180.00	27.89	3595.41
45.00	120.00	40.00	22.00	10.00	180.00	27.89	3595.41
45.00	120.00	30.00	2.50	1.00	165.56	8.31	934.66
45.00	120.00	30.00	2.50	4.00	171.30	9.40	978.91
45.00	120.00	30.00	2.50	7.00	177.03	10.49	1001.35
45.00	120.00	30.00	2.50	10.00	180.00	11.06	1004.32
45.00	120.00	30.00	9.00	1.00	165.56	14.81	1865.56
45.00	120.00	30.00	9.00	4.00	171.30	15.90	1909.80
45.00	120.00	30.00	9.00	7.00	177.03	16.99	1932.25
45.00	120.00	30.00	9.00	10.00	180.00	17.56	1935.22
45.00	120.00	30.00	16.00	1.00	165.56	21.81	2868.06
45.00	120.00	30.00	16.00	4.00	171.30	22.90	2912.31
45.00	120.00	30.00	16.00	7.00	177.03	23.99	2934.75
45.00	120.00	30.00	16.00	10.00	180.00	24.56	2937.72
45.00	120.00	30.00	22.00	1.00	165.56	27.81	3727.35
45.00	120.00	30.00	22.00	4.00	171.30	28.90	3771.60
45.00	120.00	30.00	22.00	7.00	177.03	29.99	3794.04
45.00	120.00	30.00	22.00	10.00	180.00	30.56	3797.01

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
45.00	120.00	20.00	2.50	1.00	160.20	10.10	1176.25
45.00	120.00	20.00	2.50	4.00	164.92	11.53	1262.73
45.00	120.00	20.00	2.50	7.00	169.65	12.95	1326.24
45.00	120.00	20.00	2.50	10.00	174.37	14.38	1366.34
45.00	120.00	20.00	9.00	1.00	160.20	16.60	2107.15
45.00	120.00	20.00	9.00	4.00	164.92	18.03	2193.63
45.00	120.00	20.00	9.00	7.00	169.65	19.45	2257.13
45.00	120.00	20.00	9.00	10.00	174.37	20.88	2297.24
45.00	120.00	20.00	16.00	1.00	160.20	23.60	3109.66
45.00	120.00	20.00	16.00	4.00	164.92	25.03	3196.13
45.00	120.00	20.00	16.00	7.00	169.65	26.45	3259.64
45.00	120.00	20.00	16.00	10.00	174.37	27.88	3299.74
45.00	120.00	20.00	22.00	1.00	160.20	29.60	3968.95
45.00	120.00	20.00	22.00	4.00	164.92	31.03	4055.42
45.00	120.00	20.00	22.00	7.00	169.65	32.45	4118.93
45.00	120.00	20.00	22.00	10.00	174.37	33.88	4159.03
45.00	120.00	10.00	2.50	1.00	151.74	12.92	1612.87
45.00	120.00	10.00	2.50	4.00	154.88	14.87	1790.62
45.00	120.00	10.00	2.50	7.00	158.01	16.83	1948.75
45.00	120.00	10.00	2.50	10.00	161.15	18.78	2086.78
45.00	120.00	10.00	9.00	1.00	151.74	19.42	2543.77
45.00	120.00	10.00	9.00	4.00	154.88	21.37	2721.52
45.00	120.00	10.00	9.00	7.00	158.01	23.33	2879.65
45.00	120.00	10.00	9.00	10.00	161.15	25.28	3017.68
45.00	120.00	10.00	16.00	1.00	151.74	26.42	3546.28
45.00	120.00	10.00	16.00	4.00	154.88	28.37	3724.02
45.00	120.00	10.00	16.00	7.00	158.01	30.33	3882.15
45.00	120.00	10.00	16.00	10.00	161.15	32.28	4020.18
45.00	120.00	10.00	22.00	1.00	151.74	32.42	4405.57
45.00	120.00	10.00	22.00	4.00	154.88	34.37	4583.31
45.00	120.00	10.00	22.00	7.00	158.01	36.33	4741.44
45.00	120.00	10.00	22.00	10.00	161.15	38.28	4879.47

*********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER ***********

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
45.00	140.00	40.00	2.50	1.00	167.92	7.53	977.24
45.00	140.00	40.00	2.50	4.00	174.10	8.47	1012.01
45.00	140.00	40.00	2.50	7.00	180.00	9.37	1022.97
45.00	140.00	40.00	2.50	10.00	180.00	9.37	1022.97
45.00	140.00	40.00	9.00	1.00	167.92	14.03	2063.29
45.00	140.00	40.00	9.00	4.00	174.10	14.97	2098.06
45.00	140.00	40.00	9.00	7.00	180.00	15.87	2109.02
45.00	140.00	40.00	9.00	10.00	180.00	15.67	2109.02
45.00	140.00	40.00	16.00	1.00	167.92	21.03	3232.88
45.00	140.00	40.00	16.00	4.00	174.10	21.97	3267.65
45.00	140.00	40.00	16.00	7.00	180.00	22.87	3278.61
45.00	140.00	40.00	16.00	10.00	180.00	22.87	3278.61
45.00	140.00	40.00	22.00	1.00	167.92	27.03	4235.38
45.00	140.00	40.00	22.00	4.00	174.10	27.97	4270.15
45.00	140.00	40.00	22.00	7.00	180.00	28.87	4281.11
45.00	140.00	40.00	22.00	10.00	180.00	28.87	4281.11
45.00	140.00	30.00	2.50	1.00	163.82	8.89	1178.41
45.00	140.00	30.00	2.50	4.00	169.22	10.09	1244.41
45.00	140.00	30.00	2.50	7.00	174.63	11.29	1284.18
45.00	140.00	30.00	2.50	10.00	180.00	12.48	1297.37
45.00	140.00	30.00	9.00	1.00	163.82	15.39	2264.46
45.00	140.00	30.00	9.00	4.00	169.22	16.59	2330.45
45.00	140.00	30.00	9.00	7.00	174.63	17.79	2370.23
45.00	140.00	30.00	9.00	10.00	180.00	18.98	2383.42
45.00	140.00	30.00	16.00	1.00	163.82	22.39	3434.05
45.00	140.00	30.00	16.00	4.00	169.22	23.59	3500.04
45.00	140.00	30.00	16.00	7.00	174.63	24.79	3539.81
45.00	140.00	30.00	16.00	10.00	180.00	25.98	3553.01
45.00	140.00	30.00	22.00	1.00	163.82	28.39	4436.55
45.00	140.00	30.00	22.00	4.00	169.22	29.59	4502.55
45.00	140.00	30.00	22.00	7.00	174.63	30.79	4542.32
45.00	140.00	30.00	22.00	10.00	180.00	31.98	4555.51

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
45.00	140.00	20.00	2.50	1.00	158.35	10.72	1477.00
45.00	140.00	20.00	2.50	4.00	162.73	12.26	1598.25
45.00	140.00	20.00	2.50	7.00	167.11	13.80	1692.96
45.00	140.00	20.00	2.50	10.00	171.48	15.34	1760.56
45.00	140.00	20.00	9.00	1.00	158.35	17.22	2563.04
45.00	140.00	20.00	9.00	4.00	162.73	18.76	2684.30
45.00	140.00	20.00	9.00	7.00	167.11	20.30	2779.00
45.00	140.00	20.00	9.00	10.00	171.48	21.84	2846.61
45.00	140.00	20.00	16.00	1.00	158.35	24.22	3732.63
45.00	140.00	20.00	16.00	4.00	162.73	25.76	3853.89
45.00	140.00	20.00	16.00	7.00	167.11	27.30	3948.59
45.00	140.00	20.00	16.00	10.00	171.48	28.84	4016.19
45.00	140.00	20.00	22.00	1.00	158.35	30.22	4735.14
45.00	140.00	20.00	22.00	4.00	162.73	31.76	4856.39
45.00	140.00	20.00	22.00	7.00	167.11	33.30	4951.10
45.00	140.00	20.00	22.00	10.00	171.48	34.84	5018.70
45.00	140.00	10.00	2.50	1.00	150.10	13.47	1988.96
45.00	140.00	10.00	2.50	4.00	152.93	15.52	2220.68
45.00	140.00	10.00	2.50	7.00	155.76	17.58	2431.03
45.00	140.00	10.00	2.50	10.00	158.59	19.64	2619.49
45.00	140.00	10.00	9.00	1.00	150.10	19.97	3075.00
45.00	140.00	10.00	9.00	4.00	152.93	22.02	3306.73
45.00	140.00	10.00	9.00	7.00	155.76	24.08	3517.07
45.00	140.00	10.00	9.00	10.00	158.59	26.14	3705.53
45.00	140.00	10.00	16.00	1.00	150.10	26.97	4244.59
45.00	140.00	10.00	16.00	4.00	152.93	29.02	4476.31
45.00	140.00	10.00	16.00	7.00	155.76	31.08	4686.66
45.00	140.00	10.00	16.00	10.00	158.59	33.14	4875.12
45.00	140.00	10.00	22.00	1.00	150.10	32.97	5247.10
45.00	140.00	10.00	22.00	4.00	152.93	35.02	5478.32
45.00	140.00	10.00	22.00	7.00	155.76	37.08	5689.17
45.00	140.00	10.00	22.00	10.00	158.59	39.14	5877.63

********** BLUNDER ANALYSIS - DUAL AIRCRAFT MANEUVER **********

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
45.00	160.00	40.00	2.50	1.00	166.51	8.00	1193.46
45.00	160.00	40.00	2.50	4.00	172.42	9.03	1244.33
45.00	160.00	40.00	2.50	7.00	178.33	10.06	1266.78
45.00	160.00	40.00	2.50	10.00	180.00	10.35	1267.93
45.00	160.00	40.00	9.00	1.00	166.51	14.50	2434.66
45.00	160.00	40.00	9.00	4.00	172.42	15.53	2485.53
45.00	160.00	40.00	9.00	7.00	178.33	16.56	2507.97
45.00	160.00	40.00	9.00	10.00	180.00	16.85	2509.12
45.00	160.00	40.00	16.00	1.00	166.51	21.50	3771.33
45.00	160.00	40.00	16.00	4.00	172.42	22.53	3822.[illegible]
45.00	160.00	40.00	16.00	7.00	178.33	23.56	3844.65
45.00	160.00	40.00	16.00	10.00	180.00	23.85	3845.80
45.00	160.00	40.00	22.00	1.00	166.51	27.50	4917.05
45.00	160.00	40.00	22.00	4.00	172.42	28.5[illegible]	4967.92
45.00	160.00	40.00	22.00	7.00	178.33	[illegible]	4990.36
45.00	160.00	40.00	22.00	10.00	180.00	29.85	4991.52
45.00	160.00	30.00	2.50	1.00	162.26	9.41	1439.88
45.00	160.00	30.00	2.50	4.00	167.38	10.71	1531.49
45.00	160.00	30.00	2.50	7.00	172.49	12.00	1592.66
45.00	160.00	30.00	2.50	10.00	177.60	13.30	1622.89
45.00	160.00	30.00	9.00	1.00	162.26	15.91	2681.07
45.00	160.00	30.00	9.00	4.00	167.38	17.21	2772.69
45.00	160.00	30.00	9.00	7.00	172.49	18.50	2833.86
45.00	160.00	30.00	9.00	10.00	177.60	19.80	2864.08
45.00	160.00	30.00	16.00	1.00	162.26	22.91	4017.75
45.00	160.00	30.00	16.00	4.00	167.38	24.21	4109.36
45.00	160.00	30.00	16.00	7.00	172.49	25.50	4170.53
45.00	160.00	30.00	16.00	10.00	177.60	26.80	4200.76
45.00	160.00	30.00	22.00	1.00	162.26	28.91	5163.47
45.00	160.00	30.00	22.00	4.00	167.38	30.21	5255.08
45.00	160.00	30.00	22.00	7.00	172.49	31.50	5316.25
45.00	160.00	30.00	22.00	10.00	177.60	32.80	5346.48

BLUNDERED DEPARTURE ANGLE (DEG.)	BLUNDERED VELOCITY (KNOTS)	BLUNDERED BANK ANGLE (DEG.)	BLUNDERED SUMMED DELAYS (SEC.)	ADJACENT SUMMED DELAYS (SEC.)	CORRECTED PARALLEL HEADINGS (DEG.)	BLUNDER CORRECTION TIME (SEC.)	BLUNDER RECOVERY AIRSPACE (FT.)
45.00	160.00	20.00	2.50	1.00	156.75	11.25	1794.76
45.00	160.00	20.00	2.50	4.00	160.83	12.89	1954.97
45.00	160.00	20.00	2.50	7.00	164.91	14.53	2085.40
45.00	160.00	20.00	2.50	10.00	168.99	16.17	2185.39
45.00	160.00	20.00	9.00	1.00	156.75	17.75	3035.96
45.00	160.00	20.00	9.00	4.00	160.83	19.39	3196.16
45.00	160.00	20.00	9.00	7.00	164.91	21.03	3326.59
45.00	160.00	20.00	9.00	10.00	168.99	22.67	3426.59
45.00	160.00	20.00	16.00	1.00	156.75	24.75	4372.63
45.00	160.00	20.00	16.00	4.00	160.83	26.39	4532.84
45.00	160.00	20.00	16.00	7.00	164.91	28.03	4653.27
45.00	160.00	20.00	16.00	10.00	168.99	29.67	4763.26
45.00	160.00	20.00	22.00	1.00	156.75	30.75	5518.35
45.00	160.00	20.00	22.00	4.00	160.83	32.39	5678.56
45.00	160.00	20.00	22.00	7.00	164.91	34.03	5800.99
45.00	160.00	20.00	22.00	10.00	168.99	35.67	5908.98
45.00	160.00	10.00	2.50	1.00	148.75	13.92	2376.08
45.00	160.00	10.00	2.50	4.00	151.33	16.06	2664.71
45.00	160.00	10.00	2.50	7.00	153.91	18.20	2930.52
45.00	160.00	10.00	2.50	10.00	156.49	20.34	3172.98
45.00	160.00	10.00	9.00	1.00	148.75	20.42	3617.27
45.00	160.00	10.00	9.00	4.00	151.33	22.56	3905.91
45.00	160.00	10.00	9.00	7.00	153.91	24.70	4171.72
45.00	160.00	10.00	9.00	10.00	156.49	26.84	4414.17
45.00	160.00	10.00	16.00	1.00	148.75	27.42	4953.95
45.00	160.00	10.00	16.00	4.00	151.33	29.56	5242.58
45.00	160.00	10.00	16.00	7.00	153.91	31.70	5508.39
45.00	160.00	10.00	16.00	10.00	156.49	33.84	5750.85
45.00	160.00	10.00	22.00	1.00	148.75	33.42	6099.66
45.00	160.00	10.00	22.00	4.00	151.33	35.56	6388.30
45.00	160.00	10.00	22.00	7.00	153.91	37.70	6654.11
45.00	160.00	10.00	22.00	10.00	156.49	39.84	6896.57